AD NUMBER

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LIMITATION CHANGES

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AUTHORITY

AWS ltr, 8 Jul 1976

AD-B010427 L

(17) Part 1

(18) SAMSO-TR-76-85-Pt-1

(6) AIR FORCE GLOBAL WEATHER CENTRAL
SYSTEM ARCHITECTURE STUDY.

FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT.

VOLUME 2.

Requirements Compilation and Analysis.

Part 1. User and Model Requirements.

SYSTEM DEVELOPMENT CORPORATION
2500 Colorado Avenue
Santa Monica, California 90406

(11) 1 Mar[redacted]76

(12) 290p.

(9) Final Report. [redacted] 1 Feb[redacted]75 - 1 Mar[redacted]76.

Distribution Statement

Distribution limited to U.S. Government Agencies only. Other requests for this document must be referred to Air Weather Service/CSE, Scott Air Force Base, Illinois, 62225.

(14) SDC-TM-(L)-5613/002/01-Pt-1

Prepared for:

DEPUTY FOR DEFENSE METEOROLOGICAL SATELLITE PROGRAM OFFICE
H.Q. SPACE & MISSILE SYSTEMS ORGANIZATION
AIR FORCE SYSTEMS COMMAND
LOS ANGELES, CALIFORNIA 90009

(15) F04701-75-C-0114

339 900

mb

SAMSO TR 76-85

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: TM-(L)-5613/002/01, Part 1 ✓
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): AIR FORCE GLOBAL WEATHER CENTRAL SYSTEM ARCHITECTURE STUDY, FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT, VOLUME 2 - Requirements Compilation and Analysis Part 1 - User and Model Requirements

5. TYPE OF REPORT & PERIOD COVERED: Final Report for Period 1 Feb 1975 - 1 Mar 1976

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

8. CONTRACT OR GRANT NUMBER(s): F04701-75-C-0114

9. PERFORMING ORGANIZATION NAME AND ADDRESS
SYSTEM DEVELOPMENT CORPORATION
2500 Colorado Avenue
Santa Monica, California 90406

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: PE351670F

11. CONTROLLING OFFICE NAME AND ADDRESS: DEPUTY FOR DEFENSE METEOROLOGICAL SATELLITE PROGRAM OFFICE
HQ SPACE & MISSILE SYSTEMS ORGANIZATION/YDA
LOS ANGELES, CALIFORNIA 90009

12. REPORT DATE: 1 March 1976

13. NUMBER OF PAGES: 288 (this volume)

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Distribution limited to U.S. Government Agencies only. Other requests for this document must be referred to Air Weather Service/CSE, Scott Air Force Base, Illinois, 62225.

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19 MAR 1976

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
data system
computer system
computer architecture
weather data processing
Air Force Global Weather Central
meteorological data processing

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This document has been prepared in partial fulfillment of CDRL line item A004 of System Development Corporation's Air Force Global Weather Central System Architecture Study contract. Efforts for this report were expended under Task 6, "Conceptual Design and Development Plan", performed under contract F04701-75-C-0114 for SAMSO, under the direction of Col. R. J. Fox, YDA.

The purpose of this study has been to optimize the entire AFGWC data process-

DD FORM 1 JAN 73 1473A EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ing system from the vantage point of current and future support requirements, addressing the AFGWC data processing system over the 1977 through 1982 time frame. This study was performed under a unique plan which allows complete traceability between user requirements, Air Force Global Weather Central operational functions, requirements levied upon the data system, a proposed component configuration which meets the data system requirements, and a system specification designed to acquire a system which meets these requirements.

The resultant system described has a number of unique features, including total hardware authentication separation of security levels, load leveling accomplished by assigning main processors in accordance with a dynamic priority queue of tasks, and a system-wide network control capability. Other key features include a central data base processor to fill requests for data from other processors, computer operations centers, the use of array processors for accomplishing difficult numerical problems, and sophisticated forecaster console support. These elements have been designed to provide 99.5% reliability in meeting user requirements.

The proposed system architecture consists of five dual processors each of which is about 3.5 times as powerful as an existing AFGWC processor (a Univac 1108). Each dual processor has an array processor which will be capable of very high performance on vector arithmetic. The array processors are used to assist on the difficult numerical problems, including the Advanced Prediction Model for the global atmosphere, as well as very fine grid cloud models and cloud probability models. Some of the new requirements that will be supported with this system are a one minute response to query interface, reentry support for Minuteman, and limited processing of high resolution (0.3 nautical mile) meteorological satellite data. In addition, cloud cover prediction for tactical weapon systems, ionospheric predictior for radio frequency management, and defense radar interference prediction will be supported by this system.

Volumes of this final System/Subsystem Summary Report are as follows:

Volume 1 - Executive Summary
Volume 2 - Requirements Compilation and Analysis (Parts 1, 2, and 3)
Volume 3 - Classified Requirements Topics (Secret)
Volume 4 - Systems Analysis and Trade Studies
Volume 5 - System Description
Volume 6 - Aerospace Ground Equipment Plan
Volume 7 - Implementation and Development Plans
Volume 8 - System Specification

14738

SAMSO-TR-76-85

System Development Corporation

AIR FORCE GLOBAL WEATHER CENTRAL

SYSTEM ARCHITECTURE STUDY

FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT

VOLUME 2

REQUIREMENTS COMPILATION AND ANALYSIS

PART 1

USER AND MODEL REQUIREMENTS

1 MARCH 1976

TM-(L)-5613/002/01
PART 1

ABSTRACT

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Volume 8 - System Specification

This volume consists of three separately bound parts, with each part oriented towards specific areas covered in Task 1. Part 1 includes user requirements analyses in Section 1.0 that summarize the impact of current and new requirements on the proposed architecture. Part 1 also contains descriptions of proposed new models for the 1977-82 time period in Section 2.0, with emphasis on data processing requirements.

In Part 2, this volume contains detailed descriptions of current and future functional characteristics of AFGWC in Section 3.0.

In Part 3, an in-depth network analysis (Section 4.0) that depicts various key interrelationships between these functions is presented. This network analysis has been instrumental in leading to the determination of processing capability that is required of this new architecture.

Another important analysis that has led to the determination of data system parameters has been the Task 1 data system characteristics summarization effort. This activity involved the compilation of a wide variety of important data system parameters across functional areas, eventually leading to the establishment of component values of the architectural domain in subsequent tasks. Results are summarized in Part 3, Section 5.0. The extensive working papers generated in this compilation process have been provided under separate cover.

SDC has also compiled a presentation of several topics involving growth, maintainability, and other aspects of general system performance. These topics appear in Part 3, Section 6.0.

Finally, SDC has compiled extensive glossaries of the terms and abbreviations encountered and used in this study. These glossaries include the abbreviations encountered in assessing user requirements (described in section 1.0), plus many others emanating from AFGWC, technical literature, and other sources, and are included after section 6.0 in Part 3 of this volume.

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RELATIONSHIP OF VOLUME STRUCTURE TO DOMAINS

This part of Volume 2 describes detailed user requirements that will impact AFGWC in the 1977-82 time period, and also describes the characteristics of several proposed meteorological models that will be employed to satisfy these requirements. In Section 1.0, user requirements are grouped into applicable categories of the Requirements Domain; namely:

R100: Special Activities
R200: Command Control Systems
R300: Emergency War Order Support
R400: Environmental Support
R500: Space Systems and Space Environment Support
R600: General

In Section 2.0, the features of proposed models are discussed, with emphasis on data processing requirements. Models are grouped into chronological order in accordance with the year in which the associated capabilities will be required.

APPLICABLE DOMAIN VS. PAGE NUMBERS

*Classified (partially or totally) – see Volume 3 for classified aspects
**Special Access requirement

VOLUME/DOMAIN RELATIONSHIPS

REQUIREMENT	FUNCTION*
R100	Special Activities
R101	F1600,2411,2415,2422,2424,2432,2232,3525,3800,4636,2414,2416-18,2431
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R103	F1600,2500,3800,2414,2416-18,2431
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R125	F2414-18,2431

*See part 2 of this volume for descriptions of functions.

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MODEL	REQUIREMENTS
	FY77
M1.	R101,104,105,126,201-3,204-14,216-18,301-5,403,411,502,510
M2.	R101,103,104,106,110-16,120,125,128,201-3,205-14,216-18,301-5,404
M3.	R101,501,518
M4.	R501,503-7,509,511-14,518
M5.	None
M6.	None
M7.	R104,106,108,110-16,119,120,128
M8.	R104,105,124,201-3,205,207-14,216-18,301-5,411,602
M9.	R104,105,104,201-3,205,207-14,216-18,301-5,404,411,602
M10.	R107,117,124,128,201-3,205,207-14,216-18,301-5
	FY78
M11.	R101,103,104,106-8,110-121,124,406,515
M12.	R101,103,104,106-8,110-121,124,305
M13.	R101,104,105,126,201-3,205,207,214,216-18,301-5,502,510
M14.	R105,106,108,109,208,216,305
M15.	R105,106,108,109,208,216,305
M16.	R503,506,511-14
	FY79
M17.	R101,103,104,106-8,110-121,124,305
M18.	R105,125,201,202,206-8,212,213,215-218,301-5,403,501,502,510
M19.	None
M20.	None

FY80

M21. None

M22. None

M23. R101,501,518

M24. R504-6,511-14,518

M25. R105,106,108,109,208,216,305

M26. R104,106,108,110-16,119,120,128

M37. R101,501,518

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M27. R107,117,124,128,201-3,205,207-14,216-18,301-5

M28. None

M29. None

M30. None

M31. None

FY82

M32. R101,104,105,125,201-3,205,207-14,216-18,301-5,502,510

M33. R101,104,105,125,201-3,205,207-14,216-18,301-5,502,510

M34. R501-19

M35. None

M38. R111-13,115,116,501

FY83

M36. None

1.0 USER REQUIREMENTS ANALYSES

This section lists a summary of requirements that will be imposed on GWC by user agencies in the 1977-82 time period, and are categorized as follows:

a. Special Activities
b. Command and Control Systems
c. Emergency War Order (EWO) Support
d. Environmental Support
e. Space Systems and Space Environment Support, and
f. General

A summary of requirements analyses are presented in Table 1, which is followed by white papers resulting from the analysis. These white papers are followed by detailed analyses af all unclassified requirements. Classified requirements are compiled under separate cover in Volume 3 of this final System/Subsystem Summary Report. Following these unclassified requirements is a series of correlation matrices that depict relationships between these user requirements and the operational functions described in Section 3.0 of this volume.

TABLE 1

USER PRODUCTS SUMMARY

LEGEND:

* Classified (partially or totally)	KEY - Key Driving Requirement
** Special Access	NC - No Change
	LI - Little Impact
	X - Included as Requirement

USER		INCLUDED	CAPABILITIES NOT INCLUDED
R100	Special Activities		
R101	AFTAC*	X	
R102	NSA	NC	
R103	DSP/FTD*	NC	
R104	RECCE Support**	NC	
R105	Remotely Piloted Vehicle Systems	KEY	Microwave Refraction Profiles and Lightning Prediction.
R106	Electro Optical Weapons Systems	KEY	
R107	Soil Conditions**	X	
R108	Space Optical Imaging Systems	KEY	Optical Turbulence
R109	High Energy Laser Systems	KEY	Optical Turbulence
R110	Program A**	NC	
R111	Program B**	NC	
R112	Program C**	NC	
R113	Program D**	KEY	
R114	Agency A**	NC	
R115	Agency B**	KEY	
R116	Simulation Support**	NC	
R117	Atmospheric Transmittance**	X	
R118	DMSP (Fine Data)**	X	
R119	TIROS-N Data Use**	X	
R120	Zoom Use**	KEY	
R121	Atmospheric Moisture**	X	
R122	WWMCCS DB Interface**	X	
R123	SATRAN**	X	Threat Assessment
R124	SAC (544th)**	X	
R125	Data Saves/Studies**	NC	
R126	Southern Hemisphere**	X	
R127	SAC Threat Assessment**		X
R128	Intelligence Support**	X	
R129	6944th**	LI	

TABLE 1 (Cont'd)

	USER	INCLUDED	CAPABILITIES NOT INCLUDED
R200	Command Control Systems (General WWMCCS)	KEY	Optimization Programs, Survivability
R201	MAC Integrated Management Systems	X	
R202	NORAD/ADC	X	
R203	USAFE	X	
R204	ADC	LI	
R205	USEUCOM	X	
R206	USREDCOM	X	
R207	FORSCOM	X	
R208	TAC	KEY	Seeability and Slant Range Visibility
R209	ALCOM	X	
R210	USSOUTHCOM	X	
R211	PACAF	X	
R212	NCA (NMCC, AFOC & ANMCC)	X	
R213	SAC	X	
R214	USAFEUR	X	
R215	AABNCP (NEACP)	NC	
R216	AWACS	KEY	Seeability
R217	Crisis Management	KEY	
R218	Computer Flight Plans	KEY	
R300	Emergency War Order Support		
R301	USAFE (SFC Area Forecast)	X	
R302	Quickstrike	X	
R303	SAC	X	
R304	Tactical Mobile Support	LI	
R305	SAC Minuteman*	KEY	
R400	Environmental Support		
R401	Fleet Numerical Weather Central	X	
R402	Automated Weather Network	LI	Graphic Support Beyond WWMCCS
R403	National Meteorological Center	X	New Formats
R404	Modernized Base Weather Station	X	Query Response Graphics Beyond WWMCCS
R405	Air Route Traffic Control Center	NC	
R406	Satellite Imagery Dissemination	KEY	
R407	Automation of Field Operation and Services	NC	
R408	Interactive Processing and Display System	KEY	
R409	Operational Security	KEY	

TABLE 1 (Cont'd)

	USER	INCLUDED	CAPABILITIES NOT INCLUDED
R410	Digital Radar	X	
R411	Field Army (TESS)	X	Automated Comm, Mesoscale Products for Remote Areas
R412	Weather Facsimile Switching Center	X	
R413	SWI Data**	X	
R414	Weather Graphics System	NC	
R415	New Weapons Systems*	X	
R416	Backup to Carswell	KEY	NOTAM, Time Degradation
R417	Backup to ETAC	X	
R500	Space Environment Support		
R501	NORAD/ADC*	KEY	
R502	NASA Space Shuttle	NC	
R503	SAC*	NC	
R504	AF Eastern Test Range	LI	
R505	AF Western Test Range	NC	
R506	AFCOMMSERV	X	
R507	BMEWS*	NC	
R508	AFSATCOM	X	
R509	Army Safeguard	LI	
R510	AF Space Transportation System	NC	
R511	Over the Horizon Back Scatter (OTHB) Radar*	KEY	
R512	Tactical Frequency Management	KEY	
R513	High Frequency Propagation Forecast for Computer Flight Plans	X	
R514	SLBM*	X	
R515	DSP (Solar)*	NC	
R516	Program A SESS**	NC	
R517	Cobra Dane*	X	
R518	World Wide SESS**	NC	
R519	Global Positioning Satellite		X
R600	General		
R601	Growth	KEY	
R602	Manpower Productivity	KEY	

R105 REMOTELY PILOTED VEHICLE SYSTEMS

a. Microwave Refraction Profiles. Refraction profiles for the microwave system are within the current technology; however, the problem is that the data required to construct such profiles for anticipated missions is from denied areas.

b. Lightning Interface with Radio Control. The capability will probably not exist to predict lightning within a practical accuracy allowing the timely response required for this application.

R108 SPACE OPTICAL IMAGING SYSTEMS

Optical Turbulence. Within the tactical or friendly area in question, performing this requires a constant check of parameters for weather that creates optical turbulence. No such model has been identified to perform this function. While such a model may be feasible, it is expected that a sizable model would be required. This further requires data from denied areas.

R109 HIGH ENERGY LASER SYSTEMS

See R108.

R123 SATRAN

Threat Assessment Capability. There is the capability to determine probabilities associated with meteorological conditions at the times in question. However, it was felt that the added requirement for threat assessment went beyond this. It implied combining these probabilities with other information external to GWC. This does not seem practical and therefore was not included as a requirement.

R127 SAC THREAT ASSESSMENT

This requirement, although alluded to, has not been defined adequately to define any resource requirement.

R200 GENERAL WWMCCS

a. Optimization Models. The requirements state: "Computer programming techniques such as linear programming, queueing theory, dynamic programming, and simulation can provide quantitative values to the command and control system" to augment the decision criteria. Decision assistance information will be provided; however, the general statement concerning sophisticated optimization techniques seems unrealistic, especially since no specific models were identified as part of the model development through 1982.

b. Survivability. Within the WWMCCS requirements, it is stated "AWS CFPs must have the capability to sustain operations at mission imperative levels over the entire spectrum of threats." The results of considering the true meaning of this requirement would probably give it the highest impact in the architectural study. Considering the "entire spectrum of threats" impacts much more than just the data system architecture. It would require a total survivability study beyond what is considered by SDC to be the scope of this contract. Under the current system conditions, no amount of hardware or software can accomplish this requirement. SDC therefore feels that the requirement should either be restated in terms which can be addressed, or that satisfaction of the normal security and reliability factors should be considered as adequate.

R208 TAC

a. Seeability. This requirement pertains to non-cloud visual impairment such as haze and smog. It is not felt that there will be the capability to support this type of requirement for tactical systems in data denied areas or to support the timeliness required.

b. Slant Range Visibility. It seems as if this requirement is linked to 'a' above as applied to the characteristics of the system. Although the requirement states "slant range", it is more likely that the requirements are altitude and obliquity functions. This is just a step beyond the other two requirements. SDC does not foresee these capabilities being available before 1982.

R216 AWACS

See R208.

R402 AUTOMATED WEATHER NETWORK

Graphic Support. SDC assumes that an upgrade in the CONUS portion of the AWN with equivalent modernization does not include the ability to transmit graphic products other than those provided by WWMCCS.

R403 NATIONAL METEOROLOGICAL CENTER

Tailored Support of NMC. If operations are disrupted at NMC, AFGWC is required to transmit a number of teletype messages and fax charts. The majority of the messages and charts required for this backup are already produced at AFGWC with only a few to be added to meet this requirement. Requiring the capability to output in a special format has a large impact on the software and, in some cases, on data storage. SDC will assume that current AFGWC formats are acceptable and that transmission indirectly through AFOS will not impact the system (see R407).

R404 MODERNIZED BASE WEATHER STATION

Query Response/Graphics. The query response problem becomes a limitless one when discussed in terms of "forecaster aids required for the MBWS". The extent of the query response and graphic capability will be that provided by

the WWMCCS data base or a slight expansion thereof (i.e., pre-defined observations, forecasts and fields). Once the basic mechanism for the WWMCCS support is provided, data will be available to other data links.

R407 AUTOMATION OF FIELD OPERATIONS AND SERVICES

It is assumed that GWC will not be a major node on the AFOS system, but will be a drop on the Omaha node. There will be some traffic in and out of AFGWC (primarily for NWS backup), using the Weather Facsimile Switching Center and teletype lines. For the purposes of this study, no major impact on AFGWC is assumed.

R411 FIELD ARMY

a. Automated Communications. Since no other means is addressed, SDC will assume that there is no dedicated line for communications as opposed to automated communications with the U. S. Army Atmospheric Science Laboratory.

b. Mesoscale Products for Remote Areas. There is no foreseen capability to have the ability to provide mesoscale surface and low level products for areas with little or no surface reports available. This will make it virtually impossible to provide such things as seeability, height of inversion bases, refractive index, and atmospheric motion prognosis for the initial several hundred feet above the surface.

R416 BACKUP TO CARSWELL

NOTAM. The NOTAM system is a pilot aid providing information on hazards to flight. This system is currently driven by Carswell. Based on requirements established during Task 1, SDC will assume that this system will not be driven by AFGWC.

R511 OVER-THE-HORIZON BACKSCATTER RADAR

The process includes transmission of spherical harmonic coefficients to the radar sites. Because of the amount of data which must be transmitted and the model run time, it can only be sent periodically. The age of received data can be as much as two to three hours. Thus, the sites will receive output from a model that is partially degraded in time.

R513 HIGH-FREQUENCY PROPAGATION FORECASTS FOR COMPUTER FLIGHT PLANS

Minimal Support. This requirement specifies revision of the worldwide capability for computation of optimum frequencies for air to ground high frequency communications. Support will be limited to no more than one hour per day of computer time.

R519 GLOBAL POSITIONING SYSTEM

No Support Required. The normal user of GPS will utilize the dual-frequency capability thus requiring no information concerning refraction correction or signal propagation. There will be single-frequency users who require support for AFGWC. At this time, no requirement has been identified nor can data system support be sized.

R601 GROWTH

From 1982-86, the AFGWC data system must be capable of being expanded to 20% annually above that capability which will reside at AFGWC at the end of the period covered by this study (i.e., 1982), while maintaining a 5% margin between 1977-82 for possible inaccuracies in sizing estimates. See R601 for more details.

(page 10 blank)

1.1 SPECIAL ACTIVITIES REQUIREMENTS

Requirement No.: R102

Major Category: Special Activities

Requirement Area: National Security Agency (NSA)

1.0 SUMMARY OF REQUIREMENT

Weather information is required in support of the NSA mission.

2.0 RELATED OPERATIONAL FUNCTIONS

F1600 - Special Projects Input Data Processing
F2500 - Special Projects Data Base and Related Computations
F3800 - Special Projects Output Processing

3.0 COMM LINK INTERFACES

KSR, DCT 2000 Output device.

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

NSA - National Security Agency
DCT - Data Communications Terminal
SDM - Selective Display Model
KSR - Designation for Teletype (send-receive) Terminal

6.0 DETAILED REQUIREMENTS

This requirement includes demanding selective information from the AFGWC data base (using SDM). The data obtained is treated as classified in light of the area and positions associated with the request.

7.0 RELATED INFORMATION

No changes to current traffic or processing is anticipated in meeting this requirement.

Requirement No.: R105

Major Category: Special Activities

Requirement Area: Remotely Piloted Vehicle (RPV) Systems

1.0 SUMMARY OF REQUIREMENT

Weather support is required for operations, control systems and target area for RPVs.

2.0 RELATED OPERATIONAL FUNCTIONS

F1600 - Special Projects Input Data Processing
F2500 - Special Projects Data Base and Related Computations
F3800 - Special Projects Output Processing

3.0 COMM LINK INTERFACES

Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	USAFETAC Report 7044	Drone RPV Automatic Loading Guidance System Climatology	Jun 73
b.	AWS/DNT Letter	AFGWC System Architecture Study	Oct 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

RPV - Remotely Piloted Vehicle

6.0 DETAILED REQUIREMENTS

AFGWC products should satisfy the following RPV support requirements:

a. Surface Wind and Crosswind Frequency data are critical in recovery. Threshold wind velocity may preclude operations. Forecasts include wind profile in 1000 feet increments to 50,000 feet.

b. Ceiling heights and visibilities for launch and recovery.

c. Temperature, pressure, density altitude at launch site.

d. Humidity.

e. Winds, temperatures, clear air and storm turbulence, hail, lightning, icing, pressure altitude, amount and heights of clouds, visibility and contrails required for airborne launch, control, and recovery.

Control System

a. CFP
b. Precipitation attenuation on radio waves.

Target Area Weather

a. Ceiling and visibility
b. Cloud free line of sight and clear line of sight

In-Flight

a. Launch/wind temperature
b. Descent winds
c. Route winds temperatures
d. Minimum altimeter settings enroute
e. Climb winds/temperatures 5,000 feet to 75,000 feet in 5,000 feet increments
f. Return winds temperatures
g. Bases and tops of contrails
h. Route Weather

7.0 RELATED INFORMATION

Two parts of the overall RPV systems requirement cannot be satisfied: the refraction profiles for microwave systems cannot be built since the data required is from denied areas. The lightning interference problem cannot be solved due to the inability to predict lightning. The total work load has not been sized; however the rest of the requirement is standard data and that required by computer flight plans. Sizing estimates can be derived by identifying the requirements for only a few flights per day.

See white paper R105.

Requirement No.: R106

Major Category: Special Activities

Requirement Area: Electro Optical Weapons Systems

1.0 SUMMARY OF REQUIREMENT

Clear line of sight (CLOS) forecasts are required for support of precision guided munitions (which use visual, infrared or microwave guidance), Space Optical Imaging Systems and High Energy Laser Systems.

2.0 RELATED OPERATIONAL FUNCTIONS

F1430, F1334 - Miscellaneous Requests Input Data Processing
F2200 - Request Processing Computations
F3600, F3700 - Dedicated Circuits and WIN Output Processing

3.0 COMM LINK INTERFACES

WIN, dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AWS/DNPP Letter	AFGWC Architecture Study	7 Oct 74
b.	AWS/DNPP Letter	AFGWC Architecture Study	9 Oct 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

CFLOS - Cloud Free Line of Sight
CLOS - Clear Line of Sight
WIN - WWMCCS Intercomputer Network
EO - Electro Optical

6.0 DETAILED REQUIREMENTS

See 7.0 below.

7.0 RELATED INFORMATION

Three classes of weapon types may be Electro-Optical (EO): 1) TV-visible; 2) infrared; and 3) microwave. For these three classes, CLOS forecasts, as a function of altitude and range, are required. Information in R108 and R109 is applicable.

Requirement No.: R108

Major Category: Special Activities

Requirement Area: Space Optical Imaging Systems

1.0 SUMMARY OF REQUIREMENT

This system requires forecast for fixed locations and friendly areas including clear line of sight forecasts for various altitude and angle situations and forecasts of optical turbulence for various atmospheric paths.

2.0 RELATED OPERATIONAL FUNCTIONS

F1434, F1420 - Command and Control System and CFLOS Input Data Processing
F2233, F2220 - Command and Control System and CFLOS Data Base and Related Computations
F3600, F3700 - Computer Driven External and WWMCCS Output Processing

3.0 COMM LINK INTERFACES

WIN, Dedicated Circuits

4.0 REFERENCES

No.	Title	Date
a. AWS/DNPP Letter	AFGWC Architecture Study	9 Oct 74
b. AWS/DNPP/Letter	AFGWC Architecture Study	7 Oct 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

SOI - Space Optical Imaging
WIN - WWMCCS Intercomputer Network
CFLOS- Cloud Free Line of Sight
CLOS - Clear Line of Sight

6.0 DETAILED REQUIREMENTS

TBD - see 7.0 below.

7.0 RELATED INFORMATION

Enhanced automation will permit combination of atmospheric transmission (including CFLOS probabilities) and operational factors to define operational requirements.

See white paper R108.

Requirement No.: R109

Major Category: Special Activities

Requirement Area: High Energy Laser Systems

1.0 SUMMARY OF REQUIREMENT

Forecasts must exist for potential hostile areas which includes clear line of sight forecasts for various altitude and angle situations. This requires forecasts of optical turbulence for various atmospheric paths.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - Command and Control Systems Input Data Processing
F2200 - Request Processing Computations
F3600, F3700 - Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AWS/DNPP Letter	AFGWC Architecture Study	9 Oct 74
b	AWS/DNPP Letter	AFGWC Architecture Study	7 Oct 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

HEL - High Energy Laser
CLOS- Clear Line of Sight
WIN - WWMCCS Intercomputer Network

6.0 DETAILED REQUIREMENTS

See 7.0 below.

7.0 RELATED INFORMATION

This requirement requires a constant check for weather that creates optical turbulence. This model has not been developed nor is there any current plan to do so. Atmospheric transmission (CLOS), combined with operational factors, will define detailed operational requirements.

The CFLOS/CLOS model must be a dynamic model giving the CLOS probability and duration for two vehicles at different locations moving at different velocities. See white paper R108.

1.2 COMMAND AND CONTROL SYSTEMS REQUIREMENTS

Requirement No.: R200

Major Category: Command and Control Systems

Requirement Area: Worldwide Military Command Control System (WWMCCS) General Requirements (applicable to R201-R218)

1.0 SUMMARY OF REQUIREMENT

Provide the decision maker at a Command and Control Center with information on the environment which will enable him to take into account the potential impact of the natural environment during the course of making a decision affecting military forces or weapons systems.

2.0 RELATED OPERATIONAL FUNCTIONS (SUMMARY)

Provide real time advice on the present and future state of the environment, through the WWMCCS Internetting System to designated WWMCCS facilities. This will be accomplished through interoperability with the WWMCCS: Standarized Applications Software, Distributed Data Base, Dispersed Support Facilities, Data Base Security, Standardized Communications Software.

3.0 COMM LINK INTERFACES

WWMCCS Internetting System (WWMCCS Intercomputer Network, AUTODIN II/IDN). The communication system will probably not be the prototype WIN system. Instead it will be a full duplex AUTODIN type of system which utilizes the Datanet 355 computer. Currently there are 2 channels associated with the AUTODIN I circuit--2 more will be added during the initial implementation of WWMCCS. The first two channels will then be eliminated. It is assumed that the 4 channel era involves basically a doubling of 2 channel characteristics.

4.0 REFERENCES

No.		Title	Date
a.	JCS (Secret Plan)	WWMCCS Objectives Plan for FY1975-1994 (U) Current Edition.	
	1. ME-200	Support File Standardization	
	2. ME-201	Standardized Applications Software	
	3. ME-202	Environmental ADP Support Facilities	
	4. ME-203	Support Distributed Data Base	
	5. ME-300	Environmental Data Base and WWMCCS ADP Comm	
	6. ME-301	Standardized Communication Software	
b.	DOD Directive 5100.30	Worldwide Military Command and Control System (WWMCCS).	
c.	DOD Directive 3020.26	Continuity of Operations - Policy and Planning	
d.	JCS (Secret Plan)	Joint Stagegic Objectives Plan (JSOP), Annex E (U).	
e.	JCS (Secret Handbook)	WWMCCS Handbook (U)	13 Jun 74
f.	JCS (Secret Plan)	WWMCCS ADP System Operational Concept (U) Appendix and Annexes A and B.	
g.	JCS Memorandum of Policy No. 139	Policy for Staff Meteorological Support to Commanders of Unified and Specified Commands	25 May 72

5.0 RELATED ABBREVIATIONS AND ACRONYMS

NCA - National Command Authority
WIN - WWMCCS Intercomputer Network
SWO - Staff Weather Officer
WSF - Weather Support Facility
ESF - Environmental Support Function
Q/R - Query/Response
CPF - Centralized Production Facilities
IDN - AUTODIN II
BSSG - Battle Staff Support Group
DDB - Distributed Data Base
ARQ - Automated Response to Query
ADWS - Automated Digital Weather Switch (Carswell)
EDB - Environmental Data Base

BUIC - Back Up Interceptor Control
DAR - Data Automation Requirement
ROC - Required Operational Capability

U. S. Unified and Specified Commands

CINCAL	- Commander in Chief	Alaska
CINC CONAD	- Commander in Chief	Continental Air Defense Command
USCINCEUR-U.S.	Commander in Chief	Europe
USCINCRED-U.S.	Commander in Chief	U. S. Readiness Command
USCINCSO-U.S.	Commander in Chief	U. S. Southern Command
CONC SAC-U.S.	Commander in Chief	Strategic Air Command

Other Commands

PACAF - Pacific Air Force
USARPAC - U. S. Army Pacific
USAFE - U. S. Air Forces, Europe
USAREUR - U. S. Army, Europe
FORSCOM - U. S. Army Forces Command
MAC - Military Airlift Command
TAC - Tactical Air Command
ADC - Aerospace Defense Command

Command Posts

NMCC - National Military Command Center
ANMCC - Alternate NMCC
AFOC - Air Force Operations Center
ABNCP - Airborne Command Post (SAC)
AABNCP - Advanced Airborne Command Post (NEACP, SAC)
NEACP - National Emergency Airborne Command Post

Other Organizations

FNWC - Fleet Numerical Weather Central
NWSED - Naval Weather Service Environmental Detachment (Ashville, N.C.)
NCC - National Climatic Center (Asheville, N. C.)
NOAA - National Oceanic and Atmospheric Administration
NWS - National Weather Service (NOAA)
EDS - Environmental Data Service (NOAA)
NOS - National Ocean Survey (NOAA)
NESS - National Environmental Satellite Service (NOAA)
NSF - National Science Foundation
ARPA - Advanced Research Projects Agency
NCAR - National Center for Atmospheric Research
NHRL - National Hurricane Research Laboratory
NOMSS - National Operational Meteorological Satellite System

6.0 DETAILED REQUIREMENTS

The capabilities of AFGWC must evolve as the command and control environmental support configuration evolve to their goal. To fulfill requirements generated by MAC, SAC, TAC and CONAD, hardware must be purchased and software generated to bridge the gap between current and future capabilities. WWMCCS environmental support production will be transformed from a man-machine mix to the point where automated products can be integrated directly into the WWMCCS decision making functions.

Besides fulfilling command and control specifications, AFGWC must pursue a program of quality control and technique development to ensure a high level of confidence for each weather product. The degree of accuracy and reliability will consider weather sensor capabilities/requirements (i.e., DMSP sensors, weather radar, tactical rainfall sensors) as well as meteorological models (i.e., 3-D nephanalysis, high resolution cloud program, sensible weather, terminal forecasts, upper wind forecasts, severe weather).

Communications. The final support configuration goal requires that AFGWC be interfaced with the WWMCCS through the WWMCCS internetting system (WWMCCS Intercomputer Network, AUTODIN II/IDN).

ADP. To produce the WWMCCS support, a substantial ADP effort will be required at AFGWC. That development effort must:

a. Develop a request analysis and schedules to execute overlays for specific requests (support to query/response).

b. Analyze requests for products and format output.

c. Establish realtime data files.

d. Develop realtime relay of scheduled products.

e. Produce in-house displays to provide support for manually generated products.

f. Provide sufficient computer power and mass storage to utilize a Selective Display Model (SDM) to meet requirements for WWMCCS environmental support products.

g. Accomplish program development and maintenance, and support management functions to satisfy standardized, as well as unique, product requirements of individual WWMCCS subsystems.

AFGWC Concepts of Operation. WWMCCS Environmental Data Bases (EDBs) will be designed and operated to meet all requirements of any command and control system. The mode of providing environmental information must insure a credible, flexible, secure, responsive, and survivable interface between AFGWC and WWMCCS.

Product Generation Procedures For AFGWC, command and control modes of data transfer are concerned with possible alternatives that will allow for the timely transfer of data, the flexibility to provide standardized products (content and format), the responsiveness required for command and control Crises Management as well as normal operations, and the capability for secure data transfer to meet OPSEC and COMSEC constraints.

a. Query/Response (Q/R). This mode allows the AFGWC to prepare a support product only when asked by a WWMCCS subsystem. It places the total environmental data base in a realtime demand posture. AFGWC will accept a query, determine the product required, produce a formatted message, and select the communications link per instructions in the query. The Q/R mode of operation will allow for high speed data access to meet time sensitive decision making. A Selective Display Model (SDM) will allow the integration of several weather factors and the capability of textual or graphic display. Q/R will be considered as emergency requests or temporary requests as defined by AWSR 105-14 to insure a responsive environmental support system throughout the transition from the manual to the manual/automated and totally automated development phases.

b. Production By Criteria. For this mode, AFGWC provides information within two constraints: as data are available and if weather parameters exceed user specified criteria/thresholds that may effect operations or plans. This production will be an evolutionary step from a manual to an automated met-watch system. Examples of by-criteria production are 1) when wind factors on a computerized flight plan exceed or change from forecast and 2) when thunderstorms increase in area coverage, intensity, or have reported funnel clouds or tornadoes. The environmental information is sent to the command and control system when identified by AFGWC and within time constraints for data delivery specified by that system.

c. Scheduled Products. In this mode, the AFGWC provides pre-defined and structured environmental support products at scheduled intervals. The products must be previously specified as a valid requirement of the user command and control subsystem. Validation of such requirements will be accomplished through established procedures (AWSR 105-14) and processed through a centralized facility assistance request (AWSR 105-18). The products are produced by AFGWC according to an established schedule, by the production cycle of weather analyses/forecasts, the availability of raw information, and the specifications/requirements of the command and control subsystem.

Data/Product Standardization. The purpose of establishing standardized data formats and products is to provide a common interface between AFGWC and the WWMCCS - any specific subsystem and all subsystems. This mode of support will allow the most cost effective mode of support while the source of the environmental data will remain transparent to the requestor; i.e., validated data will

be internally routed to access the appropriate data base. AFGWC support will include manual/computer checked and validated environmental products to meet command and control requirements within the minimum response time pre-determined by each WWMCCS subsystem. The standardized support will address three categories of environmental products:

a. Decision Assistance. This category of product generates information which can be used to assist (quantitatively or statistically) the decision maker. (Computer programming techniques such as linear programming, queueing theory, dynamic programming, and simulation can provide quantitative values to the command and control system. However, these are post-1982 requirements.) Examples of products supplied are Maximum Useable Frequency (MUF)/Lowest Useful Frequency (LUF) associated with ionospheric events, airbase status information relative to weather criteria, and probability of a cloud-free line-of-sight through the atmosphere. The environmental information under this mode represents the integration of meteorological variables which are interdependent and affect military operations.

b. Mission-Tailored. This provides environmental data (winds, temperature, severe weather, etc.) to support operations and missions requiring such data relative to execution, modification, or cancellation by a command and control decision maker. The ultimate decision is made by the operator based upon the weather information provided. Examples of such products are computerized flight plans (CFPs), time enroute bulletins (TERBs), point severe weather advisories, and sunrise/sunset-daylight/darkness information. These types of products emphasize the supportive role of weather to the decision maker.

c. Forecaster Aids. This consists of gridded and synoptic weather maps, observations, forecasts, bulletins, etc., which are used by a meteorologist to provide the best possible weather information to military operations, decisions, and plans. The products are supplied to weather forecasters, as well as Wing Weather Officers, Staff Weather Officers, Weather Support Units, and Base Weather Stations. These aids are for meteorologists, not command and control decision makers, where weather is emphasized for present and future conditions.

Areas of Uncertainty.

a. The majority of the command and control requirements for environmental information are yet to be completed or specified.

b. There may be requirements for environmental support generated by the command and control community which AWS has no technical capability to satisfy. This may affect both generation of a data base and the distribution of that data base. This may also force us to extend the state-of-the-art and develop techniques to improve product quality.

c. A need may exist to communicate outside of the DOD with other Environmental Data Bases (EDBs) for unique data, backup support, or economic reasons. Work needs to begin now on internal and external DOD coordination.

d. Because of JCS Memorandum of Policy 139, the Air Force does not have the charter to provide environmental support to all components of the WWMCCS. Thus, action must be taken at the appropriate policy making level to address the following:

1. How does WWMCCS insure mutually consistent atmospheric information where that information has the potential for being provided by different DOD environmental support agencies?

2. What Service has the responsibility for providing environmental service to those WWMCCS subsystems not specifically addressed in JCS Memorandum of Policy 139? Such subsystems include the NMCS (NMCC, ANMCC, NEACP).

7.0 RELATED INFORMATION

For this requirement, a reliability of 95% has been specified in terms of meeting the time requirement and delivering the product. The two primary factors in meeting this reliability requirement are:

a. conflicts with other message requests, and

b. reliability of the hardware.

Timing requirements include a one minute response for anything available in the WWMCCS data base, and a ten minute response if the data has to be formatted. To meet these requirements, a special data base must be designed specifically for WWMCCS.

There is no intent to meet the requirement to consider optimization techniques; i.e., the use of computer programming techniques such as linear programming, queueing theory, dynamic programming and simulation to provide quantitative values to the command and control systems. These are all contemplated for the post-1982 era. Also, nothing is planned over and above what already exists in the decision assistance area.

The current program required to perform the selective display model function is a 65K program.

The intent is not to support computer flight planning to sustain operations at mission imperative levels over the entire spectrum of threats. The requirement to be addressed in terms of the study will be 3,000 CFPs maximum load for MAC

as a daily requirement. (It is assumed that the NORAD interface fulfills the requirement for command and control systems for Air Defense Command.)

See additional comments regarding optimization models and survivability for WWMCCS under the white pages for R200.

Requirement No.: R201

Major Category: Command and Control Systems

Requirement Area: MACIMS (MAC Information Management System)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to the MACIMS by direct computer interface. Required: 1978.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, Dedicated Circuits, WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study (TAB C)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

MACIMS - MAC Information and Management System
CC, C&C - Command and Control
WIN - WWMCCS Intercomputer Network

6.0 DETAILED REQUIREMENTS

Current -	Future -
1. SFC OBS/FCSTS	1. SFC OBS/FCSTS
2. DISC BULLETINS	2. TROPICAL STRMS
3. TROPICAL STRMS	3. HAZ WX INFO
4. HAZ WX INFO	4. SVR WX INFO
5. CFP, TERB	5. WIND INFO
6. FCSTR AIDS	6. CFP, TERB
	7. POST-MSN INFO
	8. CLIMATOLOGY

7.0 RELATED INFORMATION

No definitive information except CFPs (see R218) and above products.

Requirement No.: R202

Major Category: Command and Control Systems

Requirement Area: NORAD/ADC

1.0 SUMMARY OF REQUIREMENT

Provide total environmental support to NORAD and other user agencies in the NCMC through direct computer interface. Required: 1977.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, WIN, DEDICATED CIRCUITS

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75
b.	AWS/SY Letter	AFGWC Systems Architecture Study (TAB C)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

NCMC - NORAD Cheyenne Mountain Complex
SCC - Space Computation Center

6.0 DETAILED REQUIREMENTS

Current -	Future -
1. CLOUD PROGS	1. SFC OBS/FCSTS
2. BUIC WINDS	2. CLOUD FCSTS
3. CFP, TERB	3. TROPICAL STRMS
4. IONOSPHERICS	4. SVR WX INFO
5. ELECTRON CONT	5. WIND INFO
6. FCSTR AIDS	6. SOLAR-GEO INFO
	7. REFRACTION
	8. MISSILE EVENT

Weather Messages to NORAD will consist of:

1. Airbase Weather Observations - Observed weather at selected NORAD airbases. Global Weather Central (GWC) sends this information hourly and more frequently if the observation changes.

2. Trend Forecasts - Trend weather forecasts at selected NORAD airbases. GWC sends this information every two hours and more frequently if the forecast changes.

3. Jet Stream Winds - High altitude winds observed to be greater than or equal to 75 knots. An entry is made for a maximum of 150 grid points at any altitude between 25,000 and 50,000 feet. GWC sends this data set every 12 hours. If the maximum wind appears at more than one level, multiple heights will be transmitted from GWC.

4. Severe Weather Warnings - Areas of severe weather forecasts. GWC sends this data set every six hours. The numbered areas are displayed on a background and described with a narrative.

5. Point Weather Warnings - Specific locations (NORAD airbases, radar sites, ADA sites) of severe weather forecasts. GWC sends this information as required.

6. Soviet Base Forecasts - Weather forecasts for selected Soviet staging bases. GWC sends this data set every 12 hours.

7. Wind Factors - Average wind factor forecasts for selected strike routes. GWC sends this data set every 12 hours.

8. Solar-Geophysical Forecast - 24, 48, and 72 hour forecasts of major and minor solar events, proton events, 10cm solar radio flux, geomagnetic planetary index (A_p), and high frequency (HF) propagation. Also provided is the current value of 10cm solar radio flux, geomagnetic index (A_p) and the 90-day running mean of the 10cm solar radio flux. GWC sends this data set once every 24 hours with amendments as required.

9. Solar-geophysical Event - Description of a significant solar-geophysical event that may affect a NORAD system. These events include flares, radio-bursts, shortwave fades, X-rays, polar-cap absorptions, and magnetic storms. GWC sends these reports as they occur.

10. Geomagnetic Environment - Latest observed value of the geomagnetic planetary index (A_p). A list of eight latest values and their running average will be stored in the data base. GWC sends this value every three hours with updates as required.

11. Hurricane Warning - Current position and wind speed of hurricane. Also provided is the forecast for the 6, 12, 24 and 48-hour position and wind speed. GWC sends this data set every six hours.

12. Requested Weather - A special weather report requested to support a particular circumstance. GWC sends this information as required.

13. Refractive Conditions - Propagation conditions at selected NORAD radar sites, including refractive conditions and refractivity values for a maximum of 6 layers. GWC sends this data set every 12 hours.

14. 35,000 Feet Winds - Wind forecast for the 35,000 feet level over the northern hemisphere including 59 points. GWC sends this data set every 12 hours.

15. Missile Event Analysis - An analysis of solar, ionospheric and geomagnetic conditions during a specified time period for a given location. GWC sends this report as required.

16. Baker-Nunn Forecast - Forecasts of cloud cover conditions in the vicinity of Baker-Nunn sites. GWC sends this data set once every 24 hours, amended at local midnight.

17. Look-Angle Refraction - Ionospheric conditions at selected NORAD radar sites for computation of correction factors to ionospheric refraction at various angles. GWC sends this data set every 24 hours.

7.0 RELATED INFORMATION

None.

Requirement No.: R203

Major Category: Command and Control Systems

Requirement Area: USAFE

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to USAFE's automated command and control system. Direct computer interface with AFGWC. Required: 1978.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, AWN, WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75
b.	AWS/SY Letter	AFGWC System Architecture Study (Tab c)	25 Feb 75
c.	USAFE/DO Letter(s)	Environmental Support Requirements	5 Nov 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USAFE - U. S. Air Force, Europe

6.0 DETAILED REQUIREMENTS

Current	Future
1. SFC OBS/FCSTS	1. SFC OBS/FCSTS
2. AREA FCSTS	2. SVR WX INFO
3. FALLOUT WINDS	3. WIND INFO
4. CFP, TERB	4. FALLOUT INFO
5. FCSTR AIDS	5. CFP, TERB
	6. SOLAR-GEO INFO
	7. REFRACTION
	8. SOLAR/LUNAR
	9. SEA STATE
	10. TERRESTRIAL
	11. POST-MSN INFO
	12. CLIMATOLOGY

HQ USAFE Environmental Support Requirements:

a. Real-time (surface) weather observations: preferably in plain language format for direct use by the decision maker.

1. Scheduled and/or responses to query (RQ) (updated every hour or for reportable changes).
2. For approximately 15 locations.
3. Either terminal (city, airfield, etc) or point (geographic locations).
4. Parameters to include ceilings, visibilities, surface winds, temperature, dewpoint temperature, crosswind components, sensible weather (rain, snow, fog, etc.), and pertinent remarks appended to certain observations (snow depth, 12 or 24-hour precipitation amounts, etc.).
5. Message length: 750 words.
6. Data volume: 6,000 words per day.
7. Peak load: 750 words per hour.
8. Permanent data storage: 3,000 words.
9. Data source: AFGWC.

b. Terminal Aviation Forecasts preferably formatted in plain language for for direct-use by the decision maker.

1. Scheduled or RQ (updated every 6 hours or when amended).
2. For approximately 15 locations.
3. Either terminal (city, airfield, etc.), and/or point (geographic location).
4. Parameters to include ceilings, visibilities, surface winds, sensible weather, and pertinent remarks.
5. Message length: 1,500 words.
6. Data volume: 6,000 words per day.
7. Peak load: 1,500 words per hour.
8. Permanent data storage: 3,000 words.
9. Data sources: AFGWC, ETFU, and UFC.

c. Synoptic analyses and forecast charts (facsimile).

1. Scheduled or RQ (updated every 6 hours).
2. For an area to include the area 80N 20W, to 80N 90E, to 10S 90E to 10S 40E, to 20N 20W, to 80N 20W.
3. Parameters to include winds, temperature, sensible weather, and weather depiction charts.
4. Information provided by facsimile circuits.
5. Data sources: AFGWC, ETFU.

d. Severe weather forecasts and warnings.

1. Schedule or RQ.
2. For the area described in C2 above, and for terminals of interest in that area.

3. Parameters to include thunderstorms, heavy rain, heavy snow, strong winds, turbulence, icing, and other hazards to military operations.
4. Message length: 800 words (area), 50 words (point).
5. Data volume: 5,000 words per day.
6. Peak load: 1,000 words per hour.
7. Permanent data storage: 1,200 words.
8. Data sources: AFGWC, ETFU, and UFC.

e. Wind, sea state and temperature forecasts.

1. Scheduled or RQ (updated twice per 24 hours).
2. Per the area described in c2 above.
3. Parameters to include wind-wave data, swell data, tides, water transparency, and underwater sound parameters if possible.
4. Message length: 500 words.
5. Data volume: 1,000 words per day.
6. Peak load: 500 words per hour.
7. Permanent data storage: 1,200 words.
8. Data sources: FNWC (Monterrey) and FWC (Rota).

f. Special support bulletins. This could encompass plain language summaries of weather conditions in denied territories or in areas of political and military interest.

1. RQ; then scheduled, if demand for support continues (updated at least once every 24 hours).
2. For any area or terminal within the area described in c2, above.
3. Parameters to include a discussion of the environmental situation and factors influencing that situation, terminal or point observations and/or forecasts.
4. Message length: 500 words.
5. Data volume: 500 words per day.
6. Peak load: 500 words per hour.
7. Permanent data storage: 1,000 words.
8. Data sources: AFGWC, ETFU, UFC, and FWC.

g. Climatology.

1. RQ.
2. Parameters include environmental data elements selected by the user, both historical and statistical, and probability of success indicators (PSI). (A PSI is a finished product which uses conditional climatology and operationally critical thresholds for the point/area of concern. The PSI can be used as a scheduling aid indicating the probability of having no weather delay on a planned operational mission.)
3. Message length: 500 words.
4. Data volume: 500 words per week.

5. Peak load: 500 words per hour.
6. Data storage: 10,000 words (temporary).
7. Data source: ETAC (Magnetic Tape).

h. Post-mission weather observations and analyses.

1. RQ.
2. Either geographical points, terminals, or areas.
3. Parameters to include those listed in a4 above.
4. Message length: 750 words.
5. Data Volume: 3,000 words, three times per week.
6. Peak load: 750 words per hour.
7. Permanent data storage: 3,000 words.
8. Data sources: AFGWC, ETFC, UFC, ETAC, and FWC.

i. Intermediate (1-5 days) and long-range (beyond 5 days) forecasts.

1. Scheduled or RQ.
2. For the geographical area described in c2 above.
3. Parameters to include expected precipitation, temperature and flow patterns.
4. Message length: 500 words.
5. Data volume: 3,000 words per day.
6. Peak load: 1,000 words per hour.
7. Permanent data storage: 3,000 words.
8. Data source: AFGWC.

j. Solar and lunar illumination data.

1. RQ, then scheduled, if demand persists for the data.
2. Parameters to include sun/moon rise/set, and illumination data for any location for any altitude within the geographical area described in c2, above.
3. Message length: 80 words.
4. Data volume: 80 words per day.
5. Peak load: 80 words per hour.
6. Data storage: 80 words.
7. Data sources: USNO and BTAC.

k. Low-level wind forecasts and micro-meteorological data.

1. Scheduled or RQ.
2. For point locations or geographical areas (3.0 x 3.0 degree size).
3. Parameters to include winds from the surface to 5,000 feet (11 levels) and boundary layer significant weather on a small horizontal scale.
4. Message length: 200 words.
5. Data volume: 800 words per day.
6. Peak load: 200 words per hour

7. Permanent data storage: 800 words.
8. Data sources: AFGWC, ETFU and UFC.

l. Forecasts of significant enroute weather (Computer Flight Plans).

1. Scheduled or RQ.
2. For air routes within, and to and from the geographical area described in c2, above.
3. Parameters should include forecasts for turbulence, severe weather, icing, and winds.
4. Message length: 450 words.
5. Data volume: 1,800 words per day.
6. Peak load: 450 words per hour.
7. Permanent data storage: 1,800 words.
8. Data source: AFGWC.

m. Tropospheric refraction calculations.

1. Scheduled or RQ.
2. For geographical points and areas within the area described in c2, above.
3. Parameters to include a tabular summary of tropospheric refraction.
4. Message length: 200 words.
5. Data volume: 800 words per day.
6. Peak load: 200 words per hour.
7. Permanent data storage: 800 words.
8. Data source: AFGWC.

n. Ground surface data.

1. Scheduled or RQ.
2. For geographical points and areas described in c2, above.
3. Parameters to include phenomena that affect vehicle traffic on and off established roadways (precipitation amounts and depths, ice, temperature extremes, and state of the ground summaries).
4. Message length: 400 words.
5. Data volume: 1,600 words per day.
6. Peak load: 400 words per hour.
7. Permanent data storage: 1,600 words.
8. Data sources: AFGWC, UFC, and ETFU.

o. Solar and geomagnetic observations and forecasts.

1. Scheduled, but a variable schedule dependent upon solar activity.
2. Parameters to include a summary of the event, and a forecast for onset/end one-half decay. Particle type, and channel band width.

3. Message length: 150 words.
4. Data volume: 450 words per day.
5. Peak load: 150 words per hour.
6. Permanent data storage: 1,200 words.
7. Data source: AFGWC.

p. Nuclear fallout data and plots.

1. Scheduled or RQ.
2. For up to 10 points in the geographical area described in c2, above.
3. Parameters to include wind direction and velocity from the surface to the troposphere for a geographical point, and a wind vs time plot for a fallout plot.
4. Message length: 200 words.
5. Data volume: 800 words per day.
6. Peak load: 200 words per hour.
7. Data storage: 800 words.
8. Data source: AFGWC.

7.0 RELATED INFORMATION

The following information was extracted from reference 'a' in a letter from DOO of HQ US Air Forces in Europe dated 15 November 1974:

SUBJECT: Validation of Weather Support Products (Your letter, 11 November 1974)
TO: CINCUSAFE/WE

The USAFE aircrew is affected daily by the accuracy and timeliness of weather data. The Air Force's on-going review of Air Weather Service products brought on by drawdown and economic constraints must not affect this accuracy and timeliness.

The Air Force Global Weather Central (AFGWC) supplies forward area forecasts to Victor Alert Forces with an update every six hours. Currently, these forecasts are approximately 70% accurate and received approximately 85% of the time by users. From an aircrew point of view, 100% accuracy with 100% reliability of receipt is desired; however, this percentage is unobtainable and unrealistic. AFGWC should establish a goal of 85% accuracy with 97% reliability of receipt of all forecast weather reports.

The Facsimile Products referred to in your letter of 11 November 1974 are used to provide routine and contingency support to the fighter and airlift forces in USAFE. These products are essential for the successful accomplishment of the USAFE mission.

The High Speed Printer Products that are projected for incorporation into Kindsbach are vital. These products would be available to combat aircrews in the event normal communications are disrupted from AFGWC to the using agency. This data is considered minimum for aircrew support in the event of hostilities.

NOTE: The USAFE requirement for solar and geomagnetic observations and forecasts is not met by one of the three standard WWMCCS messages as defined by AFGWC/DO. SF letter of 5 Aug 1974 defined SF(WPE) position; i.e., current products satisfy the requirement.

Requirement No.: R204

Major Category: Command and Control Systems

Requirement Area: Air Defense Command (ADC)

1.0 SUMMARY OF REQUIREMENT

No identified separate requirement.

2.0 RELATED OPERATIONAL FUNCTIONS

N/A.

3.0 COMM LINK INTERFACES

N/A.

4.0 REFERENCES

N/A.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ADC - Air Defense Command

6.0 DETAILED REQUIREMENTS

N/A.

7.0 RELATED INFORMATION

N/A.

Requirement No.: R205

Major Category: Command and Control Systems

Requirement Area: USEUCOM

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to USEUCOM's automated command and control system through direct AFGWC computer interface. Required: 1978.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	ASW/SY Letter	Dar, AFGWC Computer Upgrade	10 Jan 75
b.	AWS/SY Letter	AFGWC Systems Architecture Study (TAB C)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USEUCOM - United States European Command

6.0 DETAILED REQUIREMENTS

Current - 1. FCSTR AIDS

Future - 1. SFC OBS/FCSTS
2. SVR WX INFO
3. WIND INFO
4. FALLOUT INFO
5. CFP, TERB
6. SOLAR-GEO INFO
7. REFRACTION
8. SOLAR/LUNAR
9. SEA STATE
10. TERRESTRIAL
11. POST-MSN INFO
12. CLIMATOLOGY

The following information is from ECJ3-C letter of 23 November 73 entitled "Environmental Support Requirements, which appeared in reference 'a':

a. Reference USCINCEUR Command and Control System Master Plan, ROC 12-72.

b. The capability for direct acquisition of environmental data, via the WWMCCS, is required by Headquarters United States European Command (USEUCOM) in conjunction with satisfaction of the reference ROC, recently validated by the JCS. The data will be used to support routine operations; planning functions; command post exercises and alerts; the deployment/employment of USEUCOM forces in field exercises, general conflicts, or contingency operations; special projects; and post-event analyses.

c. The specific environmental support required by USEUCOM includes the routine receipt of or immediate access to:

1. Real-time weather observations.
2. Terminal aviation forecasts.
3. Synoptic analyses and prognostic charts.
4. Severe weather warnings.
5. Wind, sea state and temperature forecasts.
6. Special support bulletins.
7. Climatological data.
8. Post-weather observations and analyses.
9. Intermediate and long-range forecasts.
10. Solar and lunar illumination data.
11. Low-level wind forecasts.
12. Forecasts of significant enroute weather.
13. Tropospheric refraction calculations.
14. Ground surface data.
15. Micro-meteorological data.
16. Solar and geomagnetic observations and forecasts.
17. Nuclear fallout data and plots.

d. Any of the above environmental support could be required throughout the USEUCOM theater of responsibility. Under certain circumstances, the area of interest expands westward to include the CONUS, southeastward into the Arabian Sea, and eastward throughout the Warsaw Pact countries.

7.0 RELATED INFORMATION

None.

Requirement No.: R206

Major Category: Command and Control Systems

Requirement Area: USREDCOM

1.0 SUMMARY OF REQUIREMENT

Environmental support to USREDCOM command and control system. Direct AFGWC computer interface. Required: 1978.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USREDCOM - United States Readiness Command

6.0 DETAILED REQUIREMENTS

Current -	Future -
1. SFC OBS/FCSTS	1. SOLAR/LUNAR
2. DISC BULLETINS	2. CLIMATOLOGY
3. TROPICAL STRMS	
4. FCSTR AIDS	

7.0 RELATED INFORMATION

None.

Requirement No.: R207

Major Category: Command and Control Systems

Requirement Area: FORSCOM

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to FORSCOM's automated command and control system. Required date: TBD.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY	TESS Study, Vol. II (Confidential)	Aug 74
b.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

FORSCOM - U. S. Army Forces Command
TESS - Tactical Environmental Support System

6.0 DETAILED REQUIREMENTS

Current - None.

Future -
1. SFC OBS/FSCTS
2. SVR WX INFO
3. FALLOUT INFO
4. CBR DISPERSION
5. SOLAR-GEO INFO
6. REFRACTION
7. SOLAR/LUNAR
8. SEA STATE
9. CLIMATOLOGY

The following correspondence extracted from reference 'b' further delineates FORSCOM requirements for environmental support products:

TO: The Comm MAC Scott AFB
FROM: Comm Forscom, Ft McPherson, Ga.
SUBJECT: Environmental Support Requirements

a. Message MAC Scott AFB 181330Z Oct 74, Subject as above.
b. FM 31-3/AFM 165-4
c. Tactical Environmental Support System (TESS) Study, Volume II. Main report, coordination draft.

In response to Reference a, Specified Environmental Support Command and Control requirements identified by this HQ to be tied into WWMCCS are as follows:

a. 48-hour general forecast.
b. Climatological summary.
c. Climatological studies.
d. Weather advisory forecasts.
e. Weather warnings.
f. Point weather warnings.
g. 3-5 day weather outlook.
h. 30-day weather outlook.
i. Tide Tables.
j. Light table with calculator program.
k. Fallout met messages.
l. 24-hour aviation area forecasts.
m. Surface observations.
n. Aviation route forecasts.
o. 24-hour aviation terminal forecasts.
p. CBR Forecast.
q. Solar-geographic event/warning report.
r. Refractive index report.

Access to these environmental support requirements from AFGWC will be by query rather than on a scheduled basis. Dissemination of point weather warnings from AFGWC over the COMET II teletype to the Army point weather centers is still required.

The source document indicating the Army's need for these environmental support requirements is Reference b, Figure 2-4, although still in draft form. The TESS study, Reference c, identified Army environmental support requirements. Upon approval, this study will be the basis for the overall environmental support plan which encompasses all aspects of weather and meteorological support for the employment of Army forces in a theater of operations during the short (present to 1976) and mid (1977-1982) time frames. As such, terminology used herein to describe environmental support requirements corresponds to Table J-4, Annex J, of the TESS study.

The environmental support provided by AFGWC must be capable of being tailored to meet the varied user requirements of this command for data pertaining to its subordinate units located not only in CONUS, but in Panama, Alaska, and Hawaii as well. Additionally, environmental support information may be required on other areas of the world during CPX, JTX, and actual contingency/emergency situations.

The required implementation dates for this enviromental support have not been determined. An extensive analysis must be made to determine manpower and equipment resources which will be required to implement environmental support on this Hq's WWMCCS. After the required resources to receive and process the data have been identified, implementation will be dependent upon local WWMCCS funding to acquire these resources. Implementation dates will be provided by separate message at a later date.

RELATED INFORMATION

None.

Requirement No.: R208

Major Category: Command and Control Systems

Requirement Area: TAC

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to the Tactical Air Control System through the Tactical Weather System. TACS improvements will provide for weather input on a near real-time basis. Required: 1980.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

Communications channel to TWS is not specified in documentation (possibly through WIN). TWS interfaces with operational units through SEEK BUS.

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study (Tab D)	25 Feb 75
b	-	Concept for Operations for TWS in 1985 from DCS Plans, TAC	5 Jan 73

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ILS - Instrument Landing System
MLS - Microwave Landing System
SVR - Slant Visual Range
TACC - Tactical Air Control Center
TACS - Tactical Air Control System
TWS - Tactical Weather System
TAF - Tactical Air Forces
TABWS - Tactical Air Base Weather Station

6.0 DETAILED REQUIREMENTS

Current		Future	
1.	FALLOUT WINDS	1.	SFC OBS/FCSTS
2.	CFP, TERB	2.	SVR WX INFO
3.	FCSTR AIDS	3.	FALLOUT INFO
		4.	CBR DISPERSION
		5.	SOLAR-GEO INFO
		6.	REFRACTION
		7.	SOLAR/LUNAR
		8.	SEA STATE
		9.	CLIMATOLOGY

Cloud Free Line of Sight. The cloud free line of sight requirement will be implemented by means of a contingency window for a high resolution forecast at multiple levels. The program that is required to meet this requirement will take up about 260K words of core. It will require a minimum of 16 positions of mass storage. It is intended that the program be run twice a day. In equivalent 1108 time units, it requires 14 hours of CPU time and approximately 32 hours of wall time per update. This program will produce all of the field. The program required to extract the data will be a 55K word program. It will take approximately an hour of CPU time to run with 1.6 hours of wall time.

Slant Visual Range (SVR) Measurements. Documented as MAC ROC 3-73. The SVR system will provide measurements of the farthest distance up a given slope from which the ground point of intercept is visible. A single-ended device is desired to measure SVR along any glide path used by conventional or STOL/VTOL aircraft. SVR measurements are required to support Category II and III Instrument Landing System (ILS) operations and the future Microwave Landing System (MLS).

Status. An ESD SVR Evaluation Group prepared a report, in response to USAF directive providing results of its evaluation of current efforts by governmental agencies to develop an operational SVR measurement system. The report stated that it is premature to advocate a particular SVR system at this time; it recommended that Air Force re-evaluate SVR progress in late CY 76.

WEATHER DATA NEEDS FOR TACTICAL THEATER OPERATIONS IN THE 1980's

The following was taken from minutes of the AWS Advanced Aeronautical Computer/ Communications Systems Work Group, 28-29 Jan 74, Andrews AFB, MD, pages 5-6; this list as revised by the Hq AWS PNC, 29 April 74. An asterisk (*) indicates needs that are not now within the state-of-the-art of that are not readily obtainable.

Required by the Weapon System

a. Primary and secondary target weather.

1. Cloud free line of sight (CFLOS)/clear line of sight (CLOS).
*2. Target seeability information
3. Ceiling heights.
*4. Wind profile (Q value-ballistic winds)
5. Hazardous weather (AFR 105-4/AWS Sup 1).

b. Enroute weather

*1. Hazardous weather (including lightning warning AFR 105-4/AWS Sup 1).
2. Flight level winds.
3. Recovery weather.

a) Terminal observation. Includes: *slant range visibility and hazardous weather (AFR 105-4/AWS Sup 1)
b) Trend forecast

The following was contained in a letter entitled "Future Requirements for Environmental Support to TAC" from DO at TAC HQ dated 9 May 75:

a. Tactical Air Force systems programmed for the 1980s include the F-15, F-16, A-10, PGMs, Improved TACS (485L), and AWACS. These systems will require highly accurate environmental data and real-time dissemination and display for mission planning/execution. Two functions with special impact are automated fragging (2-4 hours) and weapons delivery (PGMs/conventional).

b. Request that a capability for the following environmental support be programmed and developed by AWS/AFGWC for TAC planners/controllers/aircrews.

1. Frequent target observations - every 3 hours or less.

2. Accurate 3-6 hour target forecasts. Ceiling between 25,000 feet and 3,000 feet to the closest 1,000 feet; ceiling below 3,000 feet to the closest 100 feet; visibilities to the closest mile; winds from surface to 25,000 feet (speed $\pm$ 5 knots; direction $\pm$ 10°); accuracy 95%. Clear line-of-sight, slant visual range, target/background reflectance, and contrast should be incorporated as technology permits.

3. Accurate 3-6 hour terminal forecasts. For the following categories of ceiling/visibility: IRF w/o alternate $\geq$ 3,000 feet/3 miles; alternate mins $<$ 1,000 feet/2 miles; below mins $<$ 200 feet/1/2 mile; accuracy 95%.

4. Real-time dissemination and display - less than 1 minute with 97% reliability.

c. Future requirements for computer flight plans (CFPs) and RPV weather support are under consideration.

7.0 RELATED INFORMATION

SDC will consider meeting this requirement only to the extent that the current procedures can support it. SDC will not consider providing target seeability information or slant range visibility for recovery.

See white paper R208.

Requirement No.: R209

Major Category: Command and Control Systems

Requirement Area: ALCOM

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to ALCOM's automated command area control system through direct query response access. Required: 1977.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75
b.	AWS/SY Letter	AFGWC Systems Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ALCOM - Alaska Command

6.0 DETAILED REQUIREMENTS

Current - 1. FCSTR AIDS

Future - 1. SFC OBS/FCSTS
2. CLOUD FCSTS
3. SVR WX INFO
4. WIND INFO
5. CFP, TERB
6. SEA STATE
7. TERRESTRIAL

The following information has been extracted from reference 'a'.

FROM: CINCAL, Elmendorf AFB (130015Z Nov 74)
TO: MAC/Scott AFB
SUBJECT: Environmental Support Requirements

Environmental support must be responsive to CINCAL's command and control needs. It is envisioned that in the post 1977 time frame ALCOM/ADC will require direct query response access to environmental data base with a potential system response time of 10 seconds and output of selected environmental support products within one minute.

General category environmental support required in support of command and control functions is as follows:

a. Current observations and forecasts for Alaska.
b. Current observations and forecasts for selected overseas stations.
c. NORAD gridded upper air winds.
d. Weather warnings/advisories for Alaska.
e. Oceanographic data (i.e., sea conditions, sea ice, sea temperatures, etc.)
f. Current and forecast profile cloud conditions for selected flights or flight levels.
g. Mission control forecasts (to include CFP's, area, route, and UA forecasts).
h. Tidal data.
i. Terrestrial data

These requirements will support:

a. Daily operations briefings.
b. Airlift missions
c. Fighter interceptor missions.
d. Tactical fighter missions
e. Training flights
f. Reconnaissance missions
g. Deployments and re-deployments
h. Logistic support operations
i. Disaster control (e.g. fire suppression and flood fight)
j. Rescue and recovery operations (Air Sea rescue)
k. Aircraft re-fueling
l. Target selection
m. Mission timing
n. Route selection
o. Determining nuclear weapons effects, deployment and fallout distribution.
p. Intelligence information, evaluation and intelligence estimates.

The dates and times for required environmental support are contingent upon the installation and acceptance of the ALCOM WWMCCS ADPS equipment and operation of it with other command's command and control systems in WWMCCS.

Requirement No.: R210

Major Category: Command and Control Systems

Requirement Area: US Southcom

1.0 SUMMARY OF REQUIREMENT

Environmental support to US SOUTHCOM's automated command and control system. Direct access to environmental data base.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

No.	Title	Date
Attachment to US SOUTHCOM letter	Preliminary USSOUTHCOM Requirements for Weather Information Through WWMCCS [Referenced in AWS/SY Letter of 10 January 75]	2 Jul 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

SOUTHCOM - U.S. Southern Command

6.0 DETAILED REQUIREMENTS

Current -	Future -
1. SFC OBS/FCSTS	1. SFC OBS/FCSTS
2. CFP, TERB	2. SVR WX INFO
3. FCSTR AIDS	3. CFP, TERB
	4. SOLAR/LUNAR
	5. CLIMATOLOGY

7.0 RELATED INFORMATION

None.

Requirement No.: R211

Major Category: Command and Control Systems

Requirement Area: Pacific Air Forces (PACAF)

1.0 SUMMARY OF REQUIREMENT

Provide automated environmental support to PACAF's command and control system. Required: 1977

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC Systems Architecture Study	25 Feb 75
b. AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

PACAF - Pacific Air Forces

6.0 DETAILED REQUIREMENTS

Current - 1. CFP, TERB
2. FCSTR AIDS

Future - 1. CLIMATOLOGY

The following additional information regarding PACAF Environmental Functional Support Requirements was extracted from the 77 Baseline DAR (ref 'b'):

a. Daily opeations briefings.
b. Airlift missions throughout PACAF.
c. Fighter interceptor missions.
d. Tactical fighter missions.

e. Training flights.
f. Reconnaissance missions.
g. Special missions.
h. Deployments and redeployments.
i. Logistic support operations.
j. Flight following and mission monitoring.
k. SIOP planning.
l. Planning, programming, and operating communications activities.
m. Disaster control (e.g., tropical storms).
n. Rescue and recovery operations (air-sea rescue).
o. Aircraft refueling.
p. Target selection.
q. Mission timing.
r. Route selection.
s. Feasibility determination (e.g., bare base).
t. Determining nuclear weapons effects, deployment and fallout distribution.
u. Intelligence information evaluation and intelligence estimates.
v. Planning for troop morale, health, and welfare.
w. Post-Mission analysis.

7.0 RELATED INFORMATION

None.

Requirement No.: R212

Major Category: Command and Control Systems

Requirement Area: NCA (NMCC, AFOC, & ANMCC)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to NCA through automated interfaces with NMCC, AFOC and ANMCC. Required: 1978 - 1980.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab c)	26 Feb 75
b.	---	WWMCCS Objectives Plan for 1975-1994 (Secret)	---

(Plus references listed under R200)

5.0 RELATED ABBREVIATIONS AND ACRONYMS

NMCC National Military Command Center
ANMCC - Alternate NMCC
AFOC - Air Force Operations Center
NCA - National Command Authority
NEACP - National Emergency Airborne Command Post

6.0 DETAILED REQUIREMENTS

Current	Future
1. SFC OBS/FCSTS	1. SFC OBS/FCSTS
2. AREA FCSTS	2. HAZ WX INFO
3. AIR STAGNATION	3. SVR WX INFO
4. DISC BULLETINS	4. WIND INFO
5. TROPICAL STRMS	5. FALLOUT INFO
6. HAZ WX INFO	6. CFP, TERB
7. MARINE INFO	7. SOLAR-GEO INFO
8. FCSTR AIDS	8. HF PROPAGATION

7.0 RELATED INFORMATION

a. See also R215 (NEACP)
b. Need definition of areas of uncertainty indicated below.
c. Need definition/identification of requirements (note lack of future requirements below).

Areas of undertainty are as follows:

Because of JCS Memorandum of Policy 139, the Air Force does not have the charter to provide environmental support to all components of the WWMCCS. Thus, action must be taken at the appropriate policy making level to address the following:

a. How does WWMCCS insure mutually consistent atmospheric information where that information has the potential for being provided by different DOD environmental support agencies?

b. What Service has the responsibility for providing environmental service to those WWMCCS subsystems not specifically addressed in JCS Memorandum of Policy 139? Such subsystems include the NMCS (NMCC, ANMCC, NEACP).

Requirement No.: R213

Major Category: Command and Control Systems

Requirement Area: SAC

1.0 SUMMARY OF REQUIREMENT

Provide total environmental support to the SACCS through the "Direct Drive" method (in the proper format for display). Required: 1975-1979.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN OUtput Processing

3.0 COMM LINK INTERFACES

SATIN IV, WIN, AUTODIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study (Tab C)	25 Feb 75
b.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75
c.	--	SAC/DOC Command Control ADP Requirements	6 Apr 73
d.	SACM55-101	Volume V	30 Sep 73 C1-18 Mar 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

See R200

6.0 DETAILED REQUIREMENTS

Current	Future
1. SFC OBS/FCSTS	1. SFC OBS/FCSTS
2. EWO ROUTES	2. HAZ WX INFO
3. GIANT LANCE MARCH TIGER	3. SVR WX INFO
4. MISSILE FCSTS	4. WIND INFO
5. FCSTR AIDS	5. FALLOUT INFO
	6. CFP, TERB
	7. SOLAR-GEO INFO
	8. HF PROPAGATION

The following SAC requirements were extracted from reference 'b':

The WWMCCS Objectives Plan specifies the environmental support objectives for SAC. SAC is entirely dependent on AFGWC for environmental support to their command and control system through the "direct drive" method. There are no plans to have a resident environmental data base in SAC's WWMCCS computers. All the required information, in the proper format for display, will come directly from AFGWC. Software support to WWMCCS facilities outside of SAC will not be provided by AFGWC.

The identification of specific environmental support products is dependent on the command and control system's sub-functions, i.e., specific actions performed by the system. Specific actions are included in Attachment 1.

The date for DOC full support should coincide with the implementation of the H6080's, i.e., 1 December 1974, unless otherwise stated in one of the mentioned references. Initial support for DOCXD and DOCXA is January 76. Full support is required by December 79.

References:

a. SAC/DOCA Document (S) Subject: Draft Advanced Airborne Command Post (AABNCP) Baseline Automation Requirements (U), 15 August 1972.

b. Directorate of Command Control ADP Requirements for Force Control, 6 April 1973.

c. DCA/AABNCP Document (S) Subject: Functional Description of the Force/Resource Status Monitoring Subsystem of the Advanced Command Post (NEACP) (U), October 1973.

d. SACM 55-101, Volume V, 30 September 1973 and C1, 18 March 1974.

ENVIRONMENTAL SUPPORT REQUIREMENTS FOR SACCS/WWMCCS

Description:

a. Forced screen displays for severe weather storms, for any location in the world, which can be selected for a given period of time by type of severe weather storm and individual severe weather storm name.

b. Forced printer displays for severe weather storms, for any location in the world, which can be selected for a given period of time by type severe weather storm and individual severe weather storm name.

c. Requestable screen displays for severe weather storms, for any location in the world, which can be selected for a given period of time by type of severe weather storm and individual severe weather storm name.

d. Requestable printer displays for severe weather storms, for any location in the world, which can be selected for a given period of time by type of severe weather storm and individual severe weather storm name.

e. Forced screen displays for information on winds which affect PACCS fallout data; i.e., winds at four levels for each of 13 grid points.

f. Forced printer displays for information on winds which affect PACCS fallout data; i.e., winds at four levels for each of 13 grid points.

g. Requestable screen displays for information on winds which affect PACCS fallout data; i.e., winds at four levels for each of 13 grid points in the CONUS and adjacent areas.

h. Requestable printer displays for information on winds which affect PACCS fallout data; i.e., winds at four levels for each of 13 grid points in the CONUS and adjacent areas.

i. Forced screen displays for information on current data concerning clear air turbulence throughout the world.

j. Forced printer displays for information on current data concerning clear air turbulence throughout the world and in scheduled and EWO air refueling areas.

k. Requestable screen displays for information on current data concerning clear air turbulence throughout the world.

l. Requestable printer displays for information on current data concerning clear air turbulence throughout the world.

m. Forced screen displays on forecast data concerning clear air turbulence throughout the world.

n. Forced printer displays on forecast data concerning clear air turbulence throughout the world and in scheduled and EWO air refueling areas.

o. Requestable screen displays on forecast data concerning clear air turbulence throughout the world.

p. Requestable printer displays on forecast data concerning clear air turbulence throughout the world.

q. Displays in map form concerning current weather for any route in the world.

r. Displays in tabular form concerning current weather for any route in the world.

s. Displays in map form concerning forecast weather for any route in the world.

t. Displays in tabular form concerning forecast weather for any route in the world.

u. Displays in map form concerning current weather for any location in the world.

v. Displays in tabular form concerning current weather for any location in the world.

w. Displays in map form concerning forecast weather for any location in the world.

x. Displays in tabular form concerning forecast weather for any location in the world.

y. Forced weather advisories when conditions drop below a prescribed minimum for SAC bases.

z. Forced weather advisories when conditions drop below a prescribed minimum for SAC bases of interest.

aa. Forced weather advisories when conditions drop below a prescribed minimum for areas through which a flight is expected to pass.

bb. Remote forecast weather data to SAC Sub C's using the SACCS data transmission system.

cc. Screen displays which are color-coded by type of marginal/severe weather along routes.

dd. Screen displays which are color-coded by type of marginal/severe weather for SAC bases.

ee. Screen displays which are color-coded by type of marginal/severe weather for SAC bases of interest.

ff. The capability to request all weather displays by mission name.

1. Screen displays of severe weather storms affecting a mission.
2. Printer displays of severe weather storms affecting a mission.
3. Screen displays of current clear air turbulence data affecting a mission.

4. Printer displays of current clear air turbulence data affecting a mission.
5. Screen displays of forecast clear air turbulence data affecting a mission.
6. Printer displays of forecast clear air turbulence affecting a mission.
7. Displays in map form concerning current weather for a route of a mission.
8. Displays in tabular form concerning current weather for a route o of a mission.
9. Displays in map form concerning forecast weather for a route of a mission.
10. Displays in tabular form concerning forecast weather for a route of a mission.
11. Displays in map form concerning current weather for locations associated with a mission.
12. Displays in tabular form concerning current weather for locations associated with a mission.
13. Displays in map form concerning forecast weather for locations associated with a mission.
14. Displays in tabular form concerning forecast weather for locations associated with a mission.
15. Screen displays which are color-coded by type of marginal/severe weather along routes of a mission.
16. Screen displays which are color-coded by type of marginal/severe weather for SAC bases associated with a mission.

gg. The capability to request all weather displays by user-compiled parameters.

hh. The ability to dynamically build request parameters for weather displays which reflect areas of special interest such as dispersal bases, NAF bases, augmentation bases, bases associated with special mission or flights, etc.

ii. The ability to dynamically modify request parameters for weather displays which reflect areas of special interest such as dispersal bases, etc.

jj. The ability to dynamically delete request parameters for weather displays which reflect areas of special interest such as dispersal bases, etc.

kk. Addressing for forced weather displays must be changeable dynamically from a SAC LCC keyboard.

ll. Scheduled computer data base updates of forecast computerized grid wind information of 6 levels, 4 forecast periods, and Northern and Southern Hemispheres for PACCS fallout calculations.

mm. Scheduled criteria terminal weather observations and forecasts for SAC interest locations of MOBs, ARBs, SBs, and DBs for computer data base updates.

nn. Requestable terminal weather observations and forecasts for any location for computer data base updates, for DDU display, and for printer message, each separately or any combination.

oo. Scheduled DMSP cloud VFR and IFR or equivalent information as well as "secondary sensor" information, all for video recording and DDU display upon request.

pp. Aircraft reports (AIREP and PIREP) received on the AABNCP.

qq. A continuing requirement for an indefinite period of time exits for HF radio frequency propagation reports to support the SAC HF/SSB system. These HF (2-30 MHz) predictions are needed on an "as required" basis along with 30 day advance predictions.

rr. The present solar flare/magnetic storm information being received will be required on a more real time basis and should include all portions of the radio frequency spectrum that will be effected by each particular flare. Additionally, the intensity and duration of each flare/storm and how it will effect communications is needed. This is an existing requirement for an indefinite period of time.

7.0 RELATED INFORMATION

The present real time goal of AFGWC for item 'rr' above is alerts within 5 minutes. No other time requirements are known to WP. Intensity, duration, and communications effects are current support procedures.

Requirement No.: R214

Major Category: Command and Control Systems

Requirement Area: U. S. Army, Europe (USAEUR)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to USAREUR command and control system by direct WWMCCS computer interface. Required: 1977-1980.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN, AUTODIN

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	DAR, AFGWC Computer Ugrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USAEUR - U. S. Army - Europe

6.0 DETAILED REQUIREMENTS

Current - 1. FCSTR AIDS

Future - 1. SFC OBS/FCSTS
2. SVR WX INFO
3. WIND INFO
4. FALLOUT INFO
5. CFP, TERB
6. SOLAR-GEO INFO
7. HF PROPAGATION
8. SOLAR/LUNAR
9. SEA STATE
10. TERRESTRIAL

The following information was extracted from the referenced document:

FROM: CINCUSAREUR (221200Z Nov 74)
TO: MAC/Scott AFB
SUBJECT: Environmental Support Requirements

a. MAC message 161330Z Oct 74, Subject as above.
b. MAC message 201650Z Nov 74, Subject as above.

IAW request in Reference a and b the following command and control needs and dates when initial and full support is required are submitted.

Needs from the Air Force Global Weather Central (AFGWC).

a. Surface Weather Observations

1. 200 locations
2. Hourly
3. Peak Load: 300 words/hour
4. Required date: 1977

b. Terminal Forecasts

1. 100 locations
2. 4 times daily
3. Peak load: 400 words/hour
4. Required date: 1977

c. Severe Weather Warnings

1. European Area
2. Approximately 2 times daily
3. Peak load: 500 words/hour
4. Required date: 1977

d. Special Non Routine Support Discussions

1. European Area
2. When required
3. Peak load: 200 words/hour
4. Required date: 1977

e. Solar and Illumination Data

1. European Area
2. Approximately once daily
3. Peak load: 25 words/hour
4. Required date: 1977

f. Low-Level Wind Forecast

1. European area
2. Four times daily
3. Peak load: 200 words/hour
4. Required date: 1978

g. Computer Flight Plans

1. US to Europe routes
2. Approximately 3 per day
3. Peak load: 450 words/hour
4. Required date: 1978

h. Solar Particle Alert Forecasts

1. As required
2. Peak load: 150 words/hour
3. Required date: 1977

i. High Frequency Radio Propogation Information

1. European area
2. 2 times daily
3. Peak load: 200 words/hour
4. Required date: 1977

j. Fallout Data

1. 12 locations
2. 4 times daily
3. Peak load: 200 words/hour
4. Required date: 1978

k. Pilot Reports

1. European area
2. Hourly
3. Peak load: 200 words/hour
4. Required date: 1978

l. Radar Information

1. 5 locations
2. Hourly
3. Peak load: 500 words/hour
4. Required date: 1978

m. Upper Air Soundings

1. 5 locations
2. 2 times daily
3. Peak load: 800 words
4. Required date: 1978

n. Army Low Level Aviation Route Weather

1. 15 routes in Germany
2. 6 times daily
3. Peak load: 300 words/hour
4. Required date: 1979

o. Fulda Gap and HOF Corridor Summaries and Forecasts

1. 2 specific areas
2. 2 times daily
3. Peak load: 200 words/hour
4. Required date: 1980

p. USAREUR AERIAL Port and Beach Supply Area Forecasts

1. 8 locations
2. 2 times daily
3. Peak load: 300 words/hour
4. Required date: 1977

q. Forward Area Weather

1. Western Warsaw pact countries
2. 2 times daily
3. Peak load: 500 words/hour
4. Required date: 1978

Dates for when this support is required from AFGWC are based on estimates of when an automatic inter-computer interface with AUTODIN becomes available and when necessary H5000 programs are available to process data and produce required reports at the HQ.

7.0 RELATED INFORMATION

None.

Requirement No.: R215

Major Category: Command and Control Systems

Requirement Area: AABNCP (NEACP)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to AABNCP (NEACP) via relay through automated command and control capability. Time period for this support would be post-1976, if required.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study (TAB C)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

AABNCP - Advanced Airborne National Command Post
NEACP - National Emergency Airborne Command Post

6.0 DETAILED REQUIREMENTS

None available.

7.0 RELATED INFORMATION

There have been no support requirements levied upon AFGWC for NEACP. If support is later required, definition of related functions, as dependent on requirements, will be needed. See also R212.

Requirement No.: R216

Major Category: Command and Control Systems

Requirement Area: Airborne Warning and Control Systems (AWACS)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support for AWACS missions for both TAC and ADC.

Initial Phase - Preformatted data on request to appropriate weather unit for relay to AWACS aircraft.

Final Phase - Direct automated support via high speed communications between GWC and the decision maker on-board the aircraft.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN, AUTODIN, SEEK BUS

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

TAF - Tactical Air Forces
TACC - Tactical Air Control Center
CRC/CRP - Control and Reporting Center Post
TABWS - Tactical Air Base Weather Station
TWAC - Tactical Weather Analysis Center
NRCC - NORAD Region Control Center
TUOC - Tactical Unit Operations Center
MOB - Main Operating Base

6.0 DETAILED INFORMATION

The types of information in each set are required during both the initial and final phases. The degree of sophistication of the support will increase and the format for the support will continually evolve into pure decision assistance information.

a. Deployment Mode. (command post)

1. Launch Base Weather
2. Refueling Forecast (refueling of AWACS and/or any other aircraft associated with the movement of AWACS).
3. Recovery Base Weather (both AWACS and aircraft under its command and control).
4. Winds Aloft.
5. Severe Weather (Launch Base/Enroute/Recovery Base, for both AWACS and associated aircraft).
6. General Outlook for Employment Mode I.

b. Employment Mode I. (TACC/RCC)

1. Primary and Secondary Target Weather

a) Cloud free line of sight (CFLOS)/clear line of sight (CLOS).
*b) Target seeability information
c) Ceiling heights
*d) Wind profile (Q-value-ballistic winds).
e) Hazardous weather.

*Indicates products currently beyond the state of the art.

2. Enroute weather

a) Hazardous weather.
b) Flight level winds
c) Recovery weather

3. Anomalous Propagation

c. Employment Mode II. (CRC/CRP/Patrol)

1. Launch weather
2. Recovery weather
3. Severe weather
4. Winds aloft for intercept
5. Anomalous Propagation

7.0 RELATED INFORMATION

Airborne Warning and Control System: For the purpose of this study the target seeability requirement will not be considered. The assumption for the study is that this is not a flight following requirement. It is assumed for the purpose of the study that there will be an automated met-watch requirement where the data base is monitored if there is a change in selective parameters a message will be generated.

Cloud Free Line of Sight: The requirement will be implemented by means of a contingency window for a high resolution forecast at multiple levels. The program that is required to meet this requirement will take up about 260K words of core. It will require a minimum of 16 positions of mass storage (there are 114,688 words per position). It is intended that the program be run twice a day. In equivalent 1108 time units, it requires 14 hours of CPU time with approximately 32 hours of wall time for a single update. This program will produce all of the field. The program required to extract the data will be a 55K word program. It will take approximately an hour of CPU time to run with 1.6 hours of wall time.

See white paper R208.

Requirement No.: R217

Major Category: Command and Control Systems

Requirement Area: Crisis Management

1.0 SUMMARY OF REQUIREMENT

Provide capability over and above normal operations to support WWMCCS during crisis situations.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

WIN, AUTODIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab C)	25 Feb 75
b.	AFGWC R 55-4	Emergency/Crisis Response	17 Mar 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

AFGWC regulation 55-4 (reprinted as follows) indicates the nature of crisis management requirements:

EMERGENCY/CRISIS RESPONSE

Purpose: To provide guidance to all AFGWC sections on actions to be taken in response to emergency/crisis/wartime situations and/or unusual events which require unique support.

References:

a. MM 28-1 (S).
b. AFGWCR 55-1, Pyramid Alert.

General: There are a variety of situations in which AFGWC will be called upon to provide unique or special support. It is not possible to anticipate what actions will be required; therefore, procedures outlined below are designed to assure a relatively smooth transition into a posture where AFGWC can support the emergency/crisis situation with a minimum impact on routine support.

a. Concept. Since the environmental support requirements of a given emergency/crisis situation cannot be predefined, the fundamental concept is to develop a flexible system capable of rapid response to the peculiar demands of each situation. In every case the Commander and his staff will determine the appropriate response to the situation based on the resources available and the nature of the operations being supported. AFGWC's posture will be determined by the extent of the demands generated by the situation. Some of the options are:

1. Work Center Surge. In most cases, each work center has the ability to assume some additional workload in an emergency. In virtually every case, this surge capability will be called upon to provide the initial response and, when possible, will assure continued support for the duration of the emergency/crisis situation. Minor readjustments of internal (branch level) resources may be required and most routine production will continue.

2. Dedicated Cell. When individual work centers cannot absorb the additional workload, a dedicated cell will be established to manage the emergency/crisis support effort. Resources, from any AFGWC function, will be diverted as necessary to accomplish the task and still minimize the impact on other scheduled production.

3. Major Production Change. In the event of a major crisis situation involving many AFGWC customers, it may be necessary to significantly alter the entire production system, diverting both manual and automated resources as necessary to accomplish the tasks with which AFGWC has been levied. It is assumed that much of the normal effort in support of training activities will terminate and release some resources which can be devoted to emergency/crisis support.

4. In every situation, the Commander will appoint a project manager. This individual will function as the focal point for product preparation, dissemination and coordination. Additionally, when coordination efforts with outside agencies create a heavy

workload, a 24-hour position on the DO staff will be established to manage external coordination and allow the project manager to concentrate on internal coordination and production efforts.

b. Assumptions and Constraints:

1. AFGWC will not be augmented initially nor will it be called upon to divert resources for the augmentation of other AWS units.

2. Additional resources will be available only by extending internal duty hours and/or terminating normal activities.

3. AFGWC has no unique sources of intelligence; therefore, it may be denied some of the advanced indication of a potential emergency/crisis situation. AWS SWOs should have access to this type of information and, it is assumed, the SWOs will keep AFGWC informed.

4. AFGWC has no means of knowing the state of alert/readiness condition assumed by customer organizations. AFGWC will respond to Offutt AFB readiness conditions and/or to instructions from AWS.

5. AFGWC does not maintain exercise/contingency/war plans and relies on the SWO to provide all of the specific information required to respond with a viable environmental support package.

6. Security and OPSEC considerations will be thoroughly reviewed with the agency requesting support. There are cases where normally unclassified products may have to be classified to protect a customer's involvement/interest in a situation.

c. Procedures - Immediate Response:

1. Any work center receiving a request for support of a crisis/emergency situation or an unusual event will:

a) Immediately notify the AFGWC Duty Officer.
b) Provide any requested information (within work center capability) immediately.
c) If unique products have been requested, wait for guidance from the Commander or his representative.

2. The AFGWC Duty Officer will:

a) Immediately notify the Commander or his representative.
b) Assure that initial request for information was answered. Hard copy products will not be transmitted until the Commander has reviewed the situation.

c) Recall those key personnel designated by the Commander.
d) Alert appropriate branch duty sections of the potential requirement for additional support.
e) Review internal emergency/crisis support procedures.
f) When appropriate, recall a representative from IN so that the Commander may have immediate access to MM28-1 and/or other classified documents.

3. The Commander and his staff will:

a) Internal Coordination

1) Review customer support requests and determine products that will support the requirements.
2) Designate a project manager to supervise the support effort. This will normally be the AFGWC Duty Officer unless a dedicated cell is established.
3) Alert appropriate work centers of the potential for additional products.
4) Establish an initial package of products that will best satisfy known requirements.
5) Direct appropriate work centers to start product preparation.
6) After completion of external coordination, provide detailed instructions to the project manager and work centers.
7) Provide dedicated work space and additional people when work centers cannot accomodate the workload.
8) Designate a classified work center to review all unique data and coordinate with the project manager.
9) Provide classified facilities when required.
10) Establish a 24-hour cell within DO until coordination requirements diminish.
11) Review MM28-1 and appropriate plans.
12) Maintain a record of the sequence of events.

b) External Coordination

1) Resolve differences/conflicts in requested support with the requesting agency.
2) Verify classification of products and explore all aspects of OPSEC.
3) Alert Det 7, Carswell to the potential for new/special product transmission.
4) Alert the 1911th Comm Sq of potential changes in transmission schedules/workloads.

5) Establish satellite data requirements, coordinate changes and request emergency load changes if required.
6) Alert the 9 Wea Recon Wg of potential reconnaissance requirements.
7) Determine all addressees of special products.
8) Determine the most effective means of communications.

4. Procedures - Initial Actions: (OPR as indicated).

a) Establish and maintain sequence of events log (Duty Officer).
b) Review work schedules and recall people as required and/or adjust schedules (work centers).
c) Start continuity logs (work centers).
d) Prepare base facsimile chart cuts and labels (work centers).
e) Prepare AWN/AUTODIN message blanks (work centers).
f) Determine requirements for unique computer aids and coordinate with AD (work centers). Schedule aids as requested (AD).
g) Pass DMSP requirements to AP (work centers). Provide DMSP displays as requested and coordinate load changes with the 4000AAG (AP).
h) Determine times that products can be made available for transmission (work centers).
i) Start product preparation (work centers).
j) Document internal procedures (work centers).
k) Contact requesting agency and confirm start of support, content, classification, etc. (DO).
l) Coordinate with other AWS agencies that may be issuing conflicting products (DO).
m) Request appropriate bulletin headings from Carswell. Establish AWN routing and assure products are disseminated properly (DO).
n) Transmit procedural messages via AWN/AUTODIN/Facsimile as required (DO).
o) Submit MUM run changes to delivery data/products to dedicated communications lines and in-house devices (DO).
p) Determine AUTODIN traffic addressees (DO).
q) Make changes in facsimile schedules as required. Coordinate with the 1911th Comm Sq and assure that notices are sent to the field. Coordinate chart cancellations with the primary customers, time permitting (DO).
r) Prepare and transmit an AUTODIN message announcing the special support being provided. Include transmission times, product content, communications media, project manager's phone number, etc. As a minimum, the message will be transmitted to all customers requesting the support, AFOC, NMCC, AWS and all AWS wings (DO).
s) Respond to administrative messages as required (DO).

5. Procedures - Follow-on Actions:

a. The DO will:

1) Establish a 24-hour cell as required.
2) Relieve the project manager of external coordination whenever possible.
3) Keep higher headquarters informed of special support activities and submit reports as required.
4) Take actions under MM28-1 as required.
5) Request support from ETAC as required.
6) Request higher headquarters assistance in obtaining special data such as ship reports, PIREPs, data from deployed operating locations/areas, etc.
7) Request deployment of weather teams to emergency/crisis areas for which data is lacking.

b. The project manager will:

1) Coordinate all facets of the support effort once initial actions have been completed. The DO staff will relieve the project manager of as much external coordination as possible. Assure all support is provided as requested.
2) Request assistance through DO as required.
3) Immediately report data deficiencies to DO.
4) Brief the status of the support effort to the DO at least once daily.
5) Develop a program to monitor the quality of all special products and prepare OEP reports.
6) Maintain the log of significant events.
7) Maintain records of resources, including man-hours, expended on the special support effort.
8) Assure that copies of all special products are made available to other sections as appropriate.

c. All Sections will:

1) Immediately report data deficiencies to the project manager.
2) Refer all requests for new products, changes, additional addressees, etc., to the project manager.
3) Quality control all products and provide OEP reports as directed.
4) Maintain records of man-hours and resources expended on the special support effort.

6. Procedured - Termination of Support: The support provided for an emergency/crisis situation will place abnormal demands on AFGWC resources. Normally, such special support should be expected to continue for no longer than 60 days. When it becomes evident that the situation no longer warrants special support, DO will initiate action to terminate the activities and allow the AFGWC production system to return to normal. If the special support is expected to continue for a longer period, AFGWC will consider altering the production process to accommodate the special support package as routine production. This could require major adjustments and/or additional resources and will require higher headquarters validation. DO is responsible for acquiring the additional resources necessary to accomplish the task on a continuing basis.

7. Documentation created by this regulation will be disposed of in accordance with AFM 12-50.

/.0 RELATED INFORMATION

To meet this requirement the assumption will be made that computer flight plans increase 50% with a similar increase in other mission tailored products. It will also be the assumption that although manpower requirements increase from 50 to 70 percent in response to this requirement it will be met with assigned personnel. WWMCCS traffic can increase to five times normal traffic. The increase is only represented as a communications burst whereas the resource required to produce the products is the same as before or smaller due to the fact that the same message may be required for several different commands since support is in the same tactical area.

Requirement No.: R218

Major Category: Command Control Systems

Requirement Area: Computer Flight Plans

1.0 SUMMARY OF REQUIREMENT

Generate mission-tailored computer flight plans from user specifications of flight path and aircraft characteristics.

2.0 RELATED OPERATIONAL FUNCTIONS

F1410 - CFP Product Request Input Processing
F2210 - CFP Request Processing Computations
F3500 - AUTODIN Products Output Processing
F3700 - WWMCCS Intercomputer Network Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, WIN, Dedicated Comm Links

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study, (Tab K)	25 Feb 75
b.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75
c.	AFGWC TM 74-2	CFP System	1 Jan 74
d.	GWC Pamphlet	Global Applications Data Base	1 Jun 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

CFP - Computer Flight Plan
CHAD - Changes to the route library (changes, add/delete)
TERB - Time enroute bulletin
GADB - Global applications data base

Communications and Application Workload (as percent of one Univac 1108) is presented as follows for CFP support:

1974	1977	1980
5%	35%	40%

NOTE: 100% UNIVAC 1108 is equated to 62% UNIVAC 1110.

AFGWC will be required to modify the Global Applications Data Base to provide enhanced support needed for 1977-1980 time.

7.0 RELATED INFORMATION

It presently requires five seconds to generate a normal computer flight plan. The automated inclusion of enroute sensible and severe weather requires twenty seconds to generate. The peak load of 50 minutes CPU time for one hour is derived using 200 CPU CFPs per hour at an average of 12 seconds per request. The peak CFP cost of 1108 units is based on 3,000 CFPs per day.

6.0 DETAILED REQUIREMENTS

Provide computer flight planning support for DOD activities. Support in 1977-1980 will accomodate:

1. Peak loading of 250 per hour
2. Increase from 750/day to maximum of 3000/day
3. Optimum route and profile selection
4. Automated inclusion of enroute sensible and severe weather
5. Selection of optimum refueling areas automatically (will add 30% additional CPU time per CFP).
6. Automated inclusion of destination and alternate terminal forecasts.
7. Improved timing to support time-critical missions (e.g., combat airlift).

Workload created by user requirements for up to 3000 CFPs per day results in distribution of CPU time as follows (in terms of 1108 units):

1. 8.3 hours/day CPU time. These values are extracted from the 77-Baseline DAR. Additional calculations indicate that 10 hours/day CPU time and 39.9 hours of wall time (1108) would be required to handle 3000 requests per day.

2. 47.3 minutes CPU time peak for 1 hour. Additional calculations for 1 hour peak loading (200 requests) would require 50 minutes of CPU time and 3 hours 15 minutes of wall time.

NOTE: With current options and current level of 750 CFPs per day, 1.25 hours/day of CPU time is required.

Summary Breakdown from Tab II, Ref. b, follows:

CFP COSTS IN 1977-1980 (IN 1108 UNITS)

	CPU Hrs/Day	Wall Hrs/Day	Peak CPU (1 Hr)	Peak Wall (1 Hr)
CFP	7.5 hrs	29.9 hrs	28 min	150 min
TERB	0.7 hrs	2.8 hrs	8 min	34 min
CHAD	0.1 hrs	0.8 hrs	1.3 min	10 min
	8.3 hrs	33.5 hrs	47.3 min	194 min

1.3 EMERGENCY WAR ORDER (EWO) SUPPORT REQUIREMENTS

Requirement No.: R301

Major Category: Emergency War Order Support

Requirement Area: USAFE (SFC Area Forecast)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support to USAFE's automated system

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - CC System Input Processing
F2200 - Request Processing Computations
F3500, F3600, F3700 - AUTODIN, Dedicated Circuits, WIN Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, AWN, WIN

4.0 REFERENCES

	No.	Title	Date
a.	USAFE/DOD	Validation of Weather Support Requirements	15 Nov 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USAFE - U. S. Air Force, Europe

6.0 DETAILED REQUIREMENTS

USAFE letter, subject, "Validation of Weather Support Products," dated 15 November 1974, to CINCUSAFE/WEO:

1. The USAFE aircrew is affected daily by the accuracy and timeliness of weather data. The Air Force's on-going review of Air Weather Service products brought on by economic constraints must not affect this accuracy and timeliness.

2. The Air Force Global Weather Control (AFGWC) supplies forward area forecasts to Victor Alert Forces with an update every six hours. Currently, these forecasts are approximately 70% accurate and received approximately 85% of the time by users. From an aircrew point of view, 100% accuracy with 100% reliability of receipt is desired; however, this percentage is unattainable and unrealistic. AFGWC should establish a goal of 85% accuracy with 97% reliability of receipt of all forecast weather reports.

3. The Facsimile Products referred to in your letter of 11 November 1974 are used to provide routine and contingency support to the fighter and airlift forces in USAFE. These products are essential for the successful accomplishment of the USAFE mission.

4. The High Speed Printer Products that are projected for incorporation into Kindsbach are vital. These products would be available to combat aircrews in the event normal communications are disrupted from AFGWC to the using agency. This data is considered minimum for aircrew support in the event of hostilities.

7.0 RELATED INFORMATION

Sortie type support has not been addressed, since no specific requirement has been stated. This would be an additional TS SIOP requirement.

Requirement No.: R302

Major Cateogry: Emergency War Order (EWO) Support

Requirement Area: Quick Strike (PACAF)

1.0 SUMMARY OF REQUIREMENT

Provide environmental support for Quick Strike exercises and operational missions.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - C and C System Product Requests
F2200 - C and C System Request Processing Computations
F3700 - WWMCCS Intercomputer Network Output Processing

3.0 COMM LINK INTERFACES

AUTODIN, WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

PACAF - Pacific Air Force

6.0 DETAILED REQUIREMENTS

Prepare a forecast bulletin and also point winds (automated).

Provide computer flight plans from takeoff to destination target including return (classified TS SIOP).

SDC will assume capability the same as defined in 77 base line; that is, storage of the targets and CFPs for take-off to destination.

See R303.

7.0 RELATED INFORMATION

Implementation required in mid-1977.

Requirement No.: R303

Major Category: Emergency War Order (EWO) Support

Requirement Area: SAC

1.0 SUMMARY OF REQUIREMENT

Provide environmental support for SAC EWO operations

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - C and C Systems Product Requests
F2220 - C and C Systems Request Processing Computation
F3600, F3700 - Dedicated Circuits and WWMCCS Intercomputer Network Output Processing

3.0 COMM LINK INTERFACES

Dedicated Circuits, WIN

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

Provide required support for SAC SIOP missions including B-1 flight plans. EWO flight plans will be Top Secret SIOP (same as Quick Strike but not as many) SAC-thus far has not provided the targets.

Security problem is the largest one on the data system; the other problem is automating the assignment of weather.

SDC will assume the presence of TS SIOP targets in the data base.

7.0 RELATED INFORMATION

Post 1980 implementation along with B-1 Support.

Requirement No. R304

Major Category: Emergency War Order (EWO) Support

Requirement Area: Tactical Mobile Support

1.0 SUMMARY OF REQUIREMENTS

GWC must supply airborne and ground based tactical systems with pertinent weather information, possibly through the SEEK BUS communications system. (Some of these requirements dictate new computational capabilities at GWC.)

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - C & C System Product Requests
F2220 - C & C System Request Processing Computations
F3700 - WWMCCS Intercomputer Network Output Processing

3.0 COMM LINK INTERFACES

Ref 'a' states ". . . It is imperative, however, that some communications channel, perhaps through WWMCCS, be specifically identified for this purpose." Some kind of interface with the SEEK BUS System will be required.

4.0 REFERENCES

	No.	Title	Date
a.	--	AWS Concept Paper: Applications of SEEK BUS to Weather Data Communications.	--
b.	--	Minutes of the AWS Command Aeronautical Computer/Communications Systems Working Group, 28-29 Jan 74, Andrews AFB, Md.	--
c.	AFG 105-4/AWS	Supplement 1	--
d.	--	Concept of Operations for Tactical Weather System in 1985, Deputy Chief of Staff Plans, Hq TAC	5 Jan 73

5.0 RELATED ABBREVIATIONS AND ACRONYMS

TWS - Tactical Weather System
TACS - Tactical Air Control System
TACC - Tactical Air Control Center
CRC - Control and Reporting Center (TAC)
CRP - Control and Reporting Post
DASC - Direct Air Support Center (TAC)

TAF - Tactical Air Forces
FAC - Forward Air Controller
TACP - Tactical Air Control Party
FACP - Forward Air Command Post
PMSV - Pilot-to-Metro Service
ALCE - Airlift Control Element
TUOC - Tactical Unit Operations Center
ATWDDS - Automated Terminal Weather Display and Dissemination System
TEDDS - Tactical Environmental Display and Dissemination System
ATESS - Automated Tactical Environmental Sensor System
TABWS - Tactical Air Base Weather Station
TWAC - Tactical Weather Analysis Center
DAIS - Digital Avionics Information System
AWRS - Airborne Weather Reconnaissance System
CFLOS - Cloud free line of sight
CLOS - Clear line of sight
TDMA - Time division multiple access

6.0 DETAILED REQUIREMENTS

Weather Data Needs for Tactical Theater Operations in the 1980s

(Reference: Minutes of the AWS Advanced Aeronautical Computer/Communications Systems Work Group, 28-29 January 74, Andrews AFB, MD, pages 5-6; this list as revised by the HQ AWS PRC, 29 April 74. An asterisk (*) indicates needs that are not now within the state-of-the-art or that are not readily obtainable).

a. Required by the weapon system

1. Primary and secondary target weather.

a) Cloud free line of sight (CFLOS)/clear line of sight (CLOS)
*b) Target seeability information.
c) Ceiling heights.
*d) Wind profile (Q value-ballistic winds).
e) Hazardous weather (AFR 105-4/AWS Sup 1)

2. Enroute weather

a) Hazardous weather (including lightning warning - AFR 105-4/AWS Sup 1).
b) Flight level winds.
c) Recovery weather.

1) Terminal observation
Includes: *slant range visibility, hazardous weather (AFR 105-4/AWS Sup 1)
2) Trend forecast

b. Required by units on the ground, including command and control. See Concept of Operations for Tactical Weather System in 1985 from Deputy Chief of Staff Plans, Hq TAC, 5 Jan 73 (p 17, Figure 2). This includes everything in the referenced listing except (where SEEK BUS type communications are concerned) briefing, climatology, and satellite imagery.

c. Required by AWS from sensors on the aircraft, remotely piloted vehicles, etc.

1. Aircraft position.
2. Altitude (pressure altitude).
3. Time.
*4. Turbulence (vertical gusts).
*5. Target seeability information.
6. Winds at flight level.
7. Flight level temperature.
*8. Rareps.
*9. Humidity (liquid water content, etc).
10. Additional meteorological parameters as required.

d. For Digital Avionics Information System (DAIS) only (no SEEK BUS type communications). Should tactical aircraft be fitted with a DAIS type system, but TDMA (SEEK BUS) communications are not available, then AWS requirements will diminish greatly. Only the following would be required:

1. A method to accomodate a weather data tape.
2. The software available to integrate weather data into the aircraft navigation and display system.

7.0 RELATED INFORMATION

a. SEEK BUS is assumed to be a WWMCCS customer.
b. Quantities/rates of data to and from SEEK BUS are assumed to be the same as to the tactical command post.

Capabilities are required in 1980 and beyond. The impact does not have to deal with increased or different data but rather only the increased support requirement due to the interface. The weather van will have an input to SEEK BUS. Post strike reports may be the only data available. SEEK BUS will not interface directly with GWC. Clear and cloud free line of sight support shall be provided as in other requirements. Other support is assumed to be included in the contingency growth requirement.

1.4 ENVIRONMENTAL SUPPORT REQUIREMENTS

(page 92 blank)

Requirement No.: R401

Major Category: Environment Support

Requirement Area: Fleet Numerical Weather Central

1.0 SUMMARY OF REQUIREMENT

Provide various weather data to FNWC (primary and secondary sensor data from weather satellites).

2.0 RELATED OPERATIONAL FUNCTIONS

F4540 - FNWC Continuity of Operations Support Processing

3.0 COMM LINK INTERFACES

Apparent requirement for high speed communications satellite link to transfer high volumes of imagery data.

4.0 REFERENCES

None

5.0 RELATED ABBREVIATIONS AND ACRONYMS

FNWC - Fleet Numerical Weather Central
OLS - Operational Linear Scan

6.0 DETAILED REQUIREMENTS

Data Type[1]	Coverage	Horizontal Resolution (nm)	Frequency (hours)
1c - OLS (Smooth)	Global	6.0, 25.0	6
2c - OLS (Fine)	Selected Area(s) (1200x1200 nm)	0.3	6
3a,b,c - Vertical Sounding Profiles	Global	35.0	12
4b,c - Sea Surface Temperature Mapper	Oceans	2.5, 5,0, 25.0	12
5b,c - Microwave Mapper	Global	1.0, 6.0, 25.0	6
6 - Active Radar	Oceans	1.0, 6.0, 25.0	12

[1] Subtype Descriptors

a = raw
b = calibrated and earth located
c = mapped in stereographic or mercator projections

7.0 RELATED INFORMATION

The Navy is most interested in primary and secondary sensor information from DMSP so that it can perform its missions satisfactorily. The Navy has been able to make plans for linkup with communications satellites to receive this data in the post 1978 time period. Thus, AFGWC's support to FNWC for DMSP will only be from 77-78.

At the present time, small amounts of UNIVAC 1110 time are used to process secondary sensor data from DMSP and transmit this to FNWC. This information is currently stripped out and sent to the Navy under RTOS control on a dedicated 4800 baud circuit.

Based on extrapolation of current computer times used for processing data, Navy estimates indicate that over 5 hours of 1110 time per day would be required each day for the smooth and fine DMSP data, or over 10 hours of 1110 time for all of DMSP imagery data. This is basically a worst case assumption, and assumes that the entire global surface would be transmitted to the Navy. This obviously is an undesirable situation, especially considering the limited capabilities of the 4800 baud circuit.

The Navy has suggested that some crude preliminary filtering be accomplished at System V or its equivalent prior to transmitting the imagery data to the Navy. For example, computer time can be cut in half simply by deleting information on the southern hemisphere, which is assumedly relatively unimportant to the Navy. In addition, all land masses can be blocked out, again by some crude geographical filtering. Together, these two approaches to the filtering would cut down the amount of data that must be transmitted to a little more than 2 hours of 1110 time for the fine and smooth data.

To accommodate the transmission of the large amounts of data that would still remain, the Navy has suggested that some sort of direct high speed line (50 Kilobits) direct from System V or its equivalent should be employed (50 Kilobits is the approximate maximum CTMCs can handle). It is hoped that this kind of direct line would solve other problems wherein much input/output time has been used up in executing programs on System V and transferring them to System I for transmission.

Requirement No.: R402

Major Category: Environmental Support

Requirement Area: Automated Weather Network

1.0 SUMMARY OF REQUIREMENT

The CONUS portion of the AWN includes the Automatic Digital Weather Switch and a network of 36 loop circuits serving a variety of users through "outstations". These outstations are becoming rapidly outmoded (as are the associated circuits) and several options have been proposed to modernize this equipment. It has been postulated that response and service to users has degraded, and little or no expansion capabilities exist at these stations to accommodate higher expected loads.

2.0 RELATED OPERATIONAL FUNCTIONS

Possibly an impact on the AWN TTY input stream (F1200) - See 6.0.

3.0 COMM LINK INTERFACES

Possibly an impact on the Carswell/GWC link - See 6.0.

4.0 REFERENCES

	No.	Title	Date
a.	DAR AFCS J-73-1	Data Automation Requirements - Base Weather Station Modernization and Carswell ADWS upgrade	12 Mar 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

AWN - Automated Weather Network
ADWS - Automatic Digital Weather Switch (Carswell)
NOTAM - Notice of Airmen
ARQ - Automatic Response to Query

6.0 DETAILED REQUIREMENTS

While reference 'a' deals heavily with the upgrading of Base Weather Stations, no attention is paid to the impact on the Carswell/AFGWC link (currently a 4800 baud TTY line). Assumedly, greater traffic rates will occur as outstations can process and transmit more data. The overall impact of these increased loads on AFGWC operations must be assessed (See 7.0).

7.0 RELATED INFORMATION

The fully automated AWN is expected to be operational in 1978. The Carswell/ AFGWC link should not be saturated if outstations are automated.

As stated in white paper R402, there will be no graphic products associated with this requirement. SDC assumes that this requirement is sized under the WWMCCS plan.

Requirement No.: R403

Major Category: Environmental Support

Requirement Area: National Meteorological Center Backup

1.0 SUMMARY OF REQUIREMENT

If operations are disrupted at NMC, AFGWC will be required to transmit a number of teletype messages and FAX charts. These backup transmissions will include a wide variety of weather summaries, with emphasis on severe local storm forecasts and aviation wind forecasts.

2.0 RELATED OPERATIONAL FUNCTIONS

This backup would have negligible impact on Data Base Computation (most of the related computations are already done by AFGWC), a minimal impact on the Input functional area, and greater impact on the Support area, especially those outputs dealing with facsimile products and teletype messages. The directly impacted functional area is F4530, NWS/NMC Continuity of Operations Support Processing.

3.0 COMM LINK INTERFACES

When NMC is completely down, charts will be transmitted on the NAFAX and NAMFAX networks. Teletype bulletins will be transmitted to Carswell for further routing. When comm lines to NMC are operable, AFGWC will send digital aviation wind forecasts to NWC via high speed data link through Carswell. However, when AFOS becomes operational, AFGWC will probably be configured as a node on the National Distribution Circuit (See R407).

4.0 REFERENCES

	No.	Title	Date
a.	FCM 70-4	Federal Plan for Cooperative Backup Among Operational Processing Centers	Aug 70 & revision of 12 Jun 72
b.	FCM 74-2	Federal Plans for Cooperative Backup for Severe Local Storms and Aviation Wind Forecasts	Jan 74 & revision of 29 Mar 74
c.	—	Weather Service Operations Manual Chapter C-40	—

5.0 RELATED ABBREVIATIONS AND ACRONYMS

NMC - National Meteorological Center (Suitland, Md.)
NAFAX - National Facsimile System
NSSFC - National Severe Storms Forecast Center (Kansas City)
OEP - Office of Emergency Preparedness (Washington, D.C.)

PEPCO - Potomac Electric Power Co. (Washington, D.C.)
AFTN - Aeronautical Fixed Trelecommunications Network
APT - Automatic Picture Transmission
FOFZX - Forecast Office Facsimile Network
NCSI - National Communication System Instructions
ESSA - Environmental Science Services Administration
NOAA - National Oceanic and Atmospheric Administration
SELS - Severe Local Storms (Unit of NSSFC)
RAWARC - RAREP and Warning Coordination Circuit
WSOM - Weather Service Operations Manual
NHC - National Hurricane Center (Coral Gables, Florida)
RWCC - Regional Warning Coordination Center
WSFO - Weather Service Forecast Offices
NAMFAX - National and Aviation Meteorological Facsimile Network
SDM - Senior Duty Meteorologist (NMC)
SDO - Systems Duty Officer (AFGWC)
CAWS - Carswell Automated Weather Switch
AFCS - Air Force Communication Service

6.0 DETAILED REQUIREMENTS

It appears that the types of backup support outlined above will be required until AFOS becomes operational (Aug 1979). Backup after that time will be supplied through an AFOS drop at AFGWC. See R407 (the communications load on the system will be about the same).

The following information has been extracted from the references to indicate the expected output volumes:

Reference 'a' (Backup NAFAX Schedule):

GMT	NO	CHART DESCRIPTION	VT	AREA	MANOP HEADING
0034	1	Radar Summary (MKC)[1]	00	US	ADUS
0140	2	18 Hr Sig WX Prog	V12	ATL	FANA 1
0200	3	Surface Analysis	00	US	ASUS
0222	4	500 MB Analysis	00	US	ASUS 500
0232	5	Radar Summary (MKC)	02	US	ADUS
0242	6	850 MB Wind Plot	00	US	UXUS 850
0253	7	700 MB Wind Plot	00	US	UXUS 700
0323	8	Radar Summary (MKC)	03	US	ADUS
0400	9	Surface Analysis	00	NH	ASNH
0430	10	12, 24 Hr SFC/SIGWX Prog	V12/00	US	FXUS 1
0455	11	Surface Analysis	03	US	ASUS
0523	12	Radar Summary (MKC)	05	US	ADUS
0535	13	18 Hr 300 MB Prog	V18	NH	FUWH 38
0630	14	Radar Summary (MKC)	06	US	ADUS
0640	15	24 Hr 850 MB Prog	V00	FH	FUWH 85

[1] Products tagged "MKC" only transmitted if NSSFC at Kansas City is also down.

0650	16	24 Hr 700 MB Prog	V00	FH	FUWH 70
0705	17	500 MB/Vorticity; 0, 12, 24, 36 Hr	00	FH	FUXW 2
0722	18	36 Hr SEC/SIG WX Prog	V12	FH	FXUX 2
0733	19	18 Hr SIX WX Prog	V18	ATL	FANA 1
0745	20	VERT VEL 0, 12, 24, 36 Hr	00	FH	FVWH
0800	21	Surface Analysis	06	US	ASUS
0830	22	Radar Summary (MKC)	08	US	ADUS
0856	23	36 Hr 300 MB Prog	V12	NH	FUNH 30
0925	24	30 Hr SIG WX Prog	V06	PAC	FAPA
0934	25	Radar Summary (MKC)	09	US	ADUS
1000	26	Surface Analysis	06	NH	ASNH
1027	27	Radar Summary (MKC)	10	US	ADUS
1101	28	Severe WX Outlook (MKC)	00	US	WWUS
1106	29	Surface Analysis	09	US	ASUS
1129	30	Radar Summary (MKC)	11	US	ADUS
1210	31	Genot Period (MKC) [1]			
1230	32	Radar Summary (MKC)	12	US	ADUS
1330	33	18 Hr SIG WX Prog	V00	ATL	FANA 1
1400	34	Surface Analysis	12	US	ASUS
1422	35	500 MB Analysis	12	US	ASUS 500
1457	36	850 MB Wind Plot	12	US	UXUS
1510	37	700 MB Wind Plot	12	US	UXUS 700
1526	38	Radar Summary (MKC)	15	US	ADUS
1600	39	Surface Analysis	12	NH	ASNH
1630	40	12, 24 Hr SEC/SIG WX Prog	V00/12	US	FXUS 1
1700	41	Surface Analysis	15	US	ASUS
1735	42	18 Hr 300 MB Prog	V06	NH	FUWH 38
1800	43	Circuit Lineup			
1833	44	Radar Summary (MKC)	18	US	ADUS
1843	45	24 Hr 850 MB Prog	V12	FH	FUWH 85
1853	46	24 Hr 700 MB Prog	V12	FH	FUWH 70
1903	47	500 MB/Vorticity; 0. 12, 24, 36 Hr	12	FH	FUXW 2
1920	48	36 Hr SEC/SIG WX Prog	V00	FH	FXUS 2
1940	49	Vert Vel 0, 12, 24, 36 Hr	12	FH	FVWH
2000	50	Surface Analysis	18	US	ASUS
2030	51	Radar Summary (MKC)	20	US	ADUS
2052	52	18 Hr SIG WX Prog	V06	ATL	FANA 1
2102	53	36 Hr 300 MB Prog	V00	NH	FUNH 30
2128	54	Radar Summary (MKC)	21	US	ADUS
2147	55	30 Hr SIG WX Prog	V18	PAC	FAPA
2200	56	Surface Analysis	18	NH	ASMH
2232	57	Radar Summary (MKC)	22	US	ADUS
2300	58	Surface Analysis	21	US	ASUS
2329	59	Radar Summary (MKC)	23	US	ADUS

Reference 'b':

I. Severe Local Storms Forecasts

Teletype Products. While the backup is in effect, AFGWC will issue the following SELS products for transmission on RAWARC and Service A as required:

a. Advance Information on Watch Area
b. Severe Weather Watches

[1] No current capability at AFGWC to transmit No. 31.

c. Status Reports and All Clears
d. Severe Weather Outlook Narrative - transmitted daily near 0900Z, 1500Z, and 2100 Z.

Facsimile Products. AFGWC will prepare and transmit on NAFAX the Severe Weather Outlook Graphic at 1005Z. In addition, radar summary charts will be prepared as required by the National Facsimile Schedule, if NSSFC goes down.

II Aviation Wind Forecasts (Teletype)

When backup support is required, NMC will request the data be transmitted for the following levels: 850, 700, 500, 400, 300, 250, 200, and 150 mb.

Message format and content are as follows:

Data Time
Data Base Time
Forecast Period (12, 18, or 30 hours)
U & V Wind Components (U/2 and V/2 kts.)
Temperatures
Grid
Message Format: As described by Attachment 2 to reference b
Bulletin Headings: As described by Attachment 3 to reference b
Transmission Method: High speed data link via the Carswell Air Force Base communications computer to NMC
Volume: Approximately 8,700 bits per sector record or approximately 78,000 bits per data field (one level for one forecast period)

7.0 RELATED INFORMATION

For the purposes of this study, SDC will assume 1978 as the date of implementation. There are three parts to the backup requirement:

a. Aviation Winds - These will be supported in the same manner as current operations.

b. FAX Circuit - These will not be routinely produced and currently require an extensive manual effort. SDC will investigate the possibility of automating this function.

c. Severe Weather Function - This partially manual function may be via a link with AFOS. It will include the various watches and warnings. In general, all current formats will be used.

See white paper R403.

Requirement No.: R404

Major Category: Environmental Support

Requirement Area: Modernized Base Weather Station

1.0 SUMMARY OF REQUIREMENT

Provide centralized support (in terms of products and services) for the MBWS in 1982.

2.0 RELATED OPERATIONAL FUNCTIONS

F1436 - MBWS Product Request Input Processing
F2200 - Request Processing Computations
F3400, 3500, 3600, 3800 - AWN, AUTODIN, Dedicated Circuit, and Special Projects Output Processing, respectively

3.0 COMM LINK INTERFACES

AWN
NWS Data Link
Air Traffic Control Networks

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study (TAB F)	25 Feb 75
b.	——	Required Operational Capability Draft	February 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

MAJCOM - Major Command
NWS - National Weather Service
MBWS - Modernized Base Weather Station

6.0 DETAILED REQUIREMENTS

A requirement exists to provide centralized support to the Modernized Base Weather Station (MBWS) in 1982. Support functions will include the following:

a. Routine preparation and dissemination of terminal forecasts for CONUS Air Force and Army Bases.

b. Severe weather forecasting for the CONUS.

c. Rapid query-response access to forecaster aids required for the MBWS (to be handled by WWMCCS)

d. Maintain MetWatch functions required by MBWS.

e. Provide National Weather Service (NWS) products for the MBWS.

Note: Interface with MAJCOM command and control customers will not be with MBWS system.

7.0 RELATED INFORMATION

a. Installation of MBWS is proposed for 1980-82; Proposed IOC is "FY82" - Operational in 1982.

b. In relation to backup to Carswell in 1982, see requirements analysis under R416 for traffic requirements.

c. In relation to ARTCC, see requirement R405.

The base system will be assumed to be implemented in 1980 with an increased loading of functions. GWC will have the capability to provide all the data in the plan but the impact will depend on exactly how the plan is implemented. The problem has not been well defined. For the purposes of the architectural study, SDC will assume that there will be no query response capability beyond that which will be afforded as part of the WWMCCS capability. SDC will also assume that there will be no graphics via the automated weather net.

See white paper R404.

Requirement No.: R405

Major Category: Environmental Support

Requirement Area: ARTCC

1.0 SUMMARY OF REQUIREMENT

There is no absolute requirement for AFGWC to support or receive support from ARTCC. Cooperative information exchange for point warning is envisioned for the future. Both the frequency of the exchanging of information and the actual data exchanged will be negligible. The overall objective will be to enhance the AFGWC Point Warning (PWS) System.

2.0 RELATED OPERATIONAL FUNCTIONS

F1234 - ARTCC Input Processing
F2424 - Severe Weather Forecast/Prognosis Computations

3.0 COMM LINK INTERFACES

Telephone Circuits

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (TAB F, Attachment 6)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

PIREP - Pilot Reports
PWS - Point Warning System

6.0 DETAILED REQUIREMENTS

See 1.0.

7.0 RELATED INFORMATION

No significant impact on AFGWC's future operations are anticipated for any future coordination with ARTCC in order to enhance AFGWC's Point Warning System.

Requirement No.: R406

Major Category: Environmental Support

Requirement Area: Satellite Imagery Dissemination

1.0 SUMMARY OF REQUIREMENT

The purpose of Satellite Imagery Dissemination (SID) is to provide satellite imagery data acquisition and dissemination. This system will provide imagery from the Defense Meteorological Satellite Program (DMSP), from the NASA-NOAA/NESS SMS/GOES satellites, from other NOAA/NESS satellites, and from foreign satellite systems (as they become available) to AWS CONUS and overseas units in near real time.

2.0 RELATED OPERATIONAL FUNCTIONS

F1300 - Metsat/Imagery Input Data Processing
F2330 - Satellite Data Processing Analysis Computations
F3320 - Metsat/Imagery Computer-Assisted Output Data Processing

3.0 COMM LINK INTERFACES

Currently, DMSP inputs are received at AFGWC via land line links (soon to be routed via COMSAT). Dedicated FAX output links are now used for DMSP, but have limited expansion capability.

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (Tab F, Att. 4)	25 Feb 75
b. ---	Final Report, Site III Data Handling & Distribution Study (Harris Report)	Feb 74
c. DoD Directive 4630.1	Initial SID Programming Document	---

5.0 RELATED ABBREVIATIONS AND ACRONYMS

SID - Satellite Imagery Dissemination
DMSP - Defense Meteorological Satellite Program
METSAT - Meteorological Satellite
ROD - Required Operational Date
VHRR - Very High Resolution Radiometer
IR - Infrared
DFS - Digital Facsimile System
APT - Automated Picture Transmission
FOFAX - Forecast Office Facsimile
GOES - Geosynchronous Operational Environmental Satellite
NESS - National Environment Satellite Service

SMS - Synchronous Meteorological Satellite
VHR - Very High Resolution Visual Imagery
WHR - Very High Resolution Infrared Imagery
JTWC - Joint Typhoon Warning Center
BWS - Base Weather Station
MAJCOM WSU - Major Command Weather Support Unit
NAF WSU - Number Air Force Weather Support Unit
TFU - Tactical Forecast Unit (Yokota and Kindsbach)

6.0 DETAILED REQUIREMENTS

To insure responsive and effective weather support to AF and Army peace time, wartime, and contingency activities, AWS requires high quality satellite imagery (polar orbiting and geosynchronous) as outlined below.

Required Operational Date. The AWS SID Plan should be evaluated, validated and submitted to the Air Staff for funding in FY 76 appropriations. Expected implementation date is 1 December 1976.

Dissemination System. AFGWC is the major SID transmit site. AFGWC will provide imagery data to all CONUS SID receive sites and to selected overseas sites.

The overseas SID transmit sites will receive selected imagery data from AFGWC and direct readout of local area data from the DMSP spacecraft and other sources when available.

Data Requirements. The satellite imagery requirements depicted in Table 2 were developed based on each of the tasks that are performed by each functional weather support area. The resolution frequency, coverage and timeliness of these data were all considered (see reference 'a' for more details, particularly Annex E).

The following definitions apply:

RBS - Regional Briefing Station: an AWS BWS that is responsible for telecon weather briefing support to stations remote to its geographic location.
RES - Satellite Imagery Resolution at the Receiving Location
FREQ - Number of times imagery received each day
COVERAGE - AREA, covers larger area of interest such as the CONUS, Europe, East Pacific, West Pacific; REGION, covers smallest area of interest and varies from station to station.
TIMELINESS - Data receipt time from availability time at the SID transmitting location.

(For other abbreviations, see paragraph 5.0 above.)

7.0 RELATED INFORMATION

For the purposes of the study, SDC will evaluate the recommendations listed in the Harris study and the AWS Satellite Image Dissemination Plan.

TABLE 2 - Satellite Imagery Requirements

AWS COMPOSITE REQUIREMENT FOR SID, 0-5 YEARS

FUNCTION	RESOLUTION	FREQUENCY	COVERAGE	TIMELINESS
BWS & RBS	2nm	3/day	Area	60-100 min
	1/2nm	24/day	Region	15-60 min
MAJCOM WSU	2nm	4/day	Global	60 min
	1/2nm	4/day	Area	60 min
	1/2nm	24/day	Region	15 min
NAF WSU	2nm	3/day	Area	60-100 min
	1/2nm	24/day	Region	15-60 min
TFU	2nm	3/day	Area	60 min
	1/2nm	24/day	Region	30 min

AWS COMPOSITE REQUIREMENT FOR SID, 5-10 and 10-15 YEARS

FUNCTION	RESOLUTION	FREQUENCY	COVERAGE	TIMELINESS
BWS & RBS	1nm	8/day	Area	30 min
	1/3nm	24/day	Region	15 min
MAJCOM WSU	1nm	12/day	Global	30 min
	1/3nm	12/day	Area	30 min
	1/4nm	24/day	Region	15 min
NAF WSU	1nm	8/day	Area	30 min
	1/3nm	24/day	Region	15 min
TFU	1nm	24/day	Area	30 min
	1/8nm	24/day	Region	15 min

Requirement No.: R407

Major Category: Environmental Support

Requirement Area: Automation of Field Operations and Services (AFOS)

1.0 SUMMARY OF REQUIREMENT

When the NWS AFOS system becomes operational (≈August 1979), AFGWC will probably interface with the National Distribution Circuit for backup support to this system. It appears that AFGWC will continue to provide the same backup for weather graphic display products, severe local storms, and aviation wind forecasts as are now provided and/or anticipated in the pre-AFOS era.

2.0 RELATED OPERATIONAL FUNCTIONS

The greatest impact will probably be in the Output Processing area (possibly F3610: Computer Assisted Dedicated Circuits).

3.0 COMM LINK INTERFACES

The GWC AFOS interface will be configured as a drop on the Omaha node of the National Distribution Circuit of the AFOS system.

4.0 REFERENCES

(All in AWS/SY Letter, "AFGWC System Architecture Study")

	No.	Title	Date
a.	__	Automation of Field Operations and Services	—
b.	__	Background paper: The NWS Automation of Field Operations and Services (AFOS)	12 Feb 75
c.	__	Program Development Plan - Automation Field Operations and Services (NOAA)	Nov 74
d.	FCM70-4	Federal Plan for Cooperative Backup Among Operational Processing Centers	Aug 70 & revision of 12 Jun 72
e.	FCM74-2	Federal Plans for Cooperative Backup for Severe Local Storms and Aviation Winds Forecasts	Jan/74 & revision of 29 Mar 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

AFOS - Automation of Field Operations and Services
NDC - National Distribution Circuit
MBWS - Modernized Base Weather Station
WSFO Weather Service Forecast Office (NWS)
WSO - Weather Service Office
RAMOS - Remote Automatic Meteorological Observing System (NWS)

6.0 DETAILED REQUIREMENTS

Reference b is a background paper on the AFOS program as is conceived to be related to AWS through the 1978-1990 time frame. The major impact on AFGWC will be AFGWC's ability to satisfy the NWS backup requirements (weather graphic display products and severe local storms and aviation winds forecasts). See R403.

The AFGWC AFOS interface will be essentially configured as a drop on the Omaha node of the National Distribution Circuit (NDC).

7.0 RELATED INFORMATION

The comm function is available today.

See white paper R407.

Requirement No.: R408.1

Major Category: Environmental Support

Requirement Area: IPADS - Phase I

1.0 SUMMARY OF REQUIREMENT

Support the implementation of Phase I IPADS hardware and develop a computer driven graphics system which will optimize the man-machine production at AFGWC. This system is designed for limited operational use.

2.0 RELATED OPERATIONAL FUNCTIONS

All - especially:

F2300 - Analysis Computations
F2400 - Forecast/Prognosis Computations
F4100 - Software Development and Maintenance

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (Tab F, Att. 3)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

IPADS - Interactive Processing and Display System

6.0 DETAILED REQUIREMENTS

General

Implement and evaluate a computer driven graphics system by:

a. Developing an initial capability to digitize and store data.
b. Develop and test on-line capability.
c. Investigate Phase II concepts.
d. Specify necessary hardware to meet Phase II needs.

Computer Interface

Although the initial interface between the IPADS and the AFGWC main computers will be via hand-carried magnetic tapes, an automatic/electrical interface will be available in 1976.

Programmer Support

The applications software implemented by IPADS for this phase will be developed by AFGWC programmers.

Note: Phase I IPADS is a "test bed" development operation. As such, no operational impact is foreseeable in Phase I.

7.0 RELATED INFORMATION

This requirement will be supported.

Requirement No.: R408.2

Major Category: Environmental Support

Requirement Area: IPADS - Phase IA

1.0 SUMMARY OF REQUIREMENT

Support the Phase IA hardware of IPADS, develop special projects applications, and develop and evaluate security aspects of SPU IPADS.

2.0 RELATED OPERATIONAL FUNCTIONS

See R408.1.

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

See R408.1.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

SPU - Special Projects Units

6.0 DETAILED REQUIREMENTS

General

Primary emphasis will be to develop the capability to modify cloud data - initial efforts will be directed at 3DNEPH. Objective similar to Phase I but with emphasis on SPU applications will also be investigated. Certification of Phase IA equipment for TEMPEST operations will also be considered.

Programmer Support

The software for Phase IA will be developed by AFGWC programmers.

Computer Interface

This interface will be automated.

Note: A larger disk unit will be implemented in Phase IA than in Phase I due to special needs of the SPU.

7.0 RELATED INFORMATION

This requirement will be supported.

Requirement No.: R408.3

Major Category: Environmental Support

Requirement Area: IPADS - Phase II

1.0 SUMMARY OF REQUIREMENT

Develop philosophy and software in support of IPADS Phase II (late FY77).

2.0 RELATED OPERATIONAL FUNCTIONS

See R408.1.

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

See R408.1.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

See R408.1 and R408.2.

6.0 DETAILED REQUIREMENTS

AFGWC will provide the capability to utilize IPADS in a fully interactive manner. This phase of IPADS will consist of eight interactive storage tube/CRT operating stations and two digitizing tables.

Each operating station will exist at one of eight unique work centers.

AFGWC will provide a minimum of 9600 baud modem interface between each mini-computer and a 1108/1110 central computer.

AFGWC will provide on-line access to the 1108/1110 data base.

Programmer Support

AFGWC programmers will develop all software.

7.0 RELATED INFORMATION

None

Requirement No.: R408.4

Major Category: IPADS

Requirement Area: IPADS - Phase III

1.0 SUMMARY OF REQUIREMENT

Develop software in support of Phase III IPADS.

2.0 RELATED OPERATIONAL FUNCTIONS

See R408.1.

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

See R408.1.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

See R408.1 and R408.2.

6.0 DETAILED REQUIREMENTS

AFGWC will continue development of IPADS to meet operational needs. Candidates for development are:

a. Sequential "movies" of events, weather or cloud patterns, etc.
b. Display of digital radar
c. Real time metwatch for severe weather/flying weather
d. Update of data through direct input to the data base

7.0 RELATED INFORMATION

None

Requirement No.: R409

Major Category: Environmental Support

Requirement Area: Operational Security

1.0 SUMMARY OF REQUIREMENT

AFGWC must develop an automated capability to accept a data request from the Autodin, build a response, and send it back to the requestor and other addressees (as required) in the appropriate security mode. This requirement is essential to effective contingency and wartime support of USAF and USA forces.

2.0 RELATED OPERATIONAL FUNCTIONS

F1400 - Misc TWX/Autodin Product Request Message Inputs
F2200 - Request Processing Computations
F3500 - Autodin Output Products

3.0 COMM LINK INTERFACES

Autodin

4.0 REFERENCES

(In AWS/SY Letter, "AFGWC System Architecture Study")

	No.	Title	Date
a.	--	Classified Autodin Interface	--
b.	AWS/SYC letter	Obtaining Contingency/Exercise Weather Data (Attachment to Reference 'a')	21 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

OPSEC - Operation Security
COMSEC - Communications Security

6.0 DETAILED REQUIREMENTS

The AWS approach to accommodating this requirement will be via a 3-phase approach. First: a short term capability will be acquired recognizing that certain limitations exist. Second: a mid-term solution (to be completed within 18 months) will be developed to overcome the short term limitations. Third: a capability will be acquired as a part of the increased automated support to command and control under WWMCCS in the post-1977 time frame.

1. Short Term:

Wing Tasking	15 Mar 75
Start Evaluation	1 Apr 75
Evaluation Period Ends	1 Jul 75
Wing Reports Due AWS	15 Jul 75
AWS-Wide Procedures Implemented	1 Aug 75

2. Mid Term:

6 WW Tasking	15 Mar 75
Concept & Design to AWS	15 May 75
AWS Eval & Testing	1 Jun 75
Target Date	Jun 76

3. Long Term:

Acquire Systems I, II, and IV Upgrade	1977
Begin Software Development	1977
Acquire WWMCCS Capability	1979

More details on the mid term and long term procedures are as follows:

Mid-Term Procedures: Develop a capability at AFGWC to automatically respond to secure queries for data over Autodin. 6 WW will be tasked to develop this project. An 18-month target date for this capability will be included in the tasking. Milestones will be established after staffing at 6WW.

Long-Term Procedures: A capability will be acquired in automated support to Command and Control under WWMCCS to provide data on a query/response basis to operator and decision makers concurrently. The data base and products provided both must be mutually consistent. 6 WW will be tasked to pursue this after the upgrade of Systems I, II and IV. Milestones will be finalized after DAR approval.

It thus appears that long-term classified Autodin requirements will be met by the WWMCCS implementation (See R200A), tentatively scheduled for 1979. "Mid-term' procedures will be via classified Autodin.

7.0 RELATED INFORMATION

The most difficult problem is being able to handle the demand mode. Software (about 35K) must be built to interpret very much the same as the WWMCCS application. A smaller amount of code is needed because of the dedicated line in this application. This is not included in the 1977 baseline.

The current 2-channel Autodin will be replaced by a 4-channel circuit supporting both WWMCCS development and current Autodin. Then the current Autodin lines will be removed. The requirement for the long term is thus basically satisfied by WWMCCS.

For sizing purposes, SDC will size a 2-channel configuration with the comm load the sum of all command and control and low speed circuits AFGWC services today.

Requirement No.: R410.1

Major Category: Environmental Support

Requirement Area: Digital Radar/WR 1980 Support

1.0 SUMMARY OF REQUIREMENT

Support the AWS Weather Radar of the 1980s (WR 1980). Prototype support in FY 1980. System support beginning FY 1982. Plan yet to be approved by the Air Staff.

2.0 RELATED OPERATIONAL FUNCTIONS

F1500 - Digital Radar Input Processing
F2353 - Digital Radar Analysis Computations

3.0 COMM LINK INTERFACES

To be decided. Due to expected high data rates and volumes, a high speed line (possibly a comsat link) will probably be required to transmit preprocessed data from preprocessing sites to AFGWC.

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (Tab G, att. 9)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

WR - Weather Radar

6.0 DETAILED REQUIREMENTS

The following has been taken from page 3 of the AWS background paper of reference a:

Digital radar weather data will be acquired by the data acquisition subsystems of up to four data sources (AWS, NWS, RADAP and NEXRAD, and host nations), formatted, thresholded, compressed and otherwise treated by on-site processing systems, and communicated to AFGWC for incorporation into the data base and for use by applications software. Essential to the process is the data compression or filtering step, designed to prevent AFGWC from being overwhelmed by information it cannot use or by data rates it cannot handle. Whatever concepts are finally adopted for the application of radar weather data at AFGWC, it is clear these concepts will demand:

a. Receipt of radar weather data over communications media.

b. Storage of radar weather data in the AFGWC data base, where it must be available to applications programs and the Interactive Processing and Display System.

c. Interactive processing and display of radar weather data on demand by AFGWC forecasters.

d. Occasional high CPU demand processing associated with certain applications programs, particularly pattern recognition applications.

e. Command the data acquisition subsystems of AWS WR 1980 radars, but not the digital radar systems of other agencies and nations.

f. Archive radar weather data as required.

7.0 RELATED INFORMATION

It is assumed that 105 current TAF locations will be the sites for AWS digital radars. For effective collection and preprocessing, it is assumed that about 4 'preprocessing' sites will accept data from about 25 radars each (plus several radars from NWS), performing extensive compression of site inputs to eliminate the transmission of useless data to AFGWC. These preprocessing sites could communicate with the AFGWC by uplinking to a communications satellite, with a single downlink from this vehicle to AFGWC.

Data rates are expected to be about 2×10^5 bits/second to AFGWC for 4 seconds (one second from each of the four regional sites), with this rate occurring as often as every 15 minutes under severe weather conditions. These data rate figures were arrived at as follows (reference Figure 1).

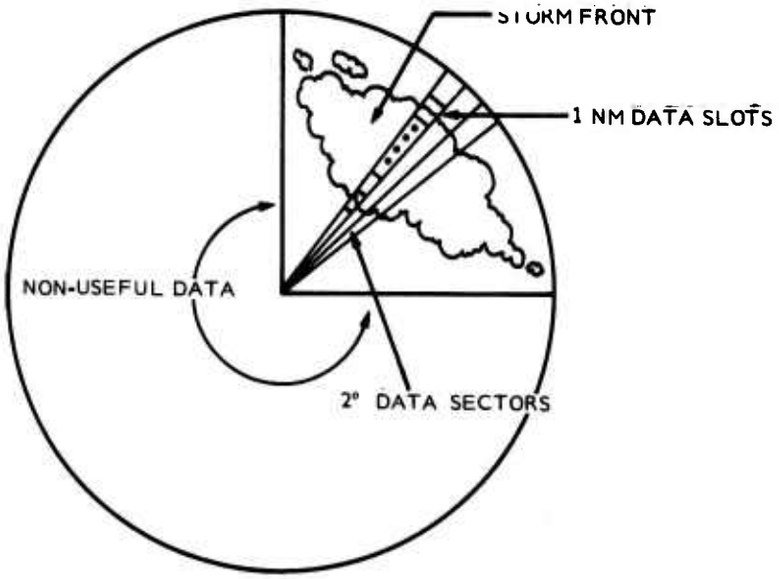

Figure 1. Assumed Storm Pattern

Assume that one digital radar scans a storm that occupies 25% of its scan area (i.e., 270^{o} of "data" would be eliminated at a preprocessing site). Assuming also that angular resolution is 2^{o} and that the linear resolution is 1 nautical mile, there can be about 20 x 45 = 900 useful "slots" of information per radar plane per 90^{o}. If the radar scans the front at 5 different elevation angles, this results in 900 x 5 = 4500 total slots of data for the radar or, at 8 bits per slot, a total of 36,000 bits for the radar. If 6 radars are seeing the same storm under the same conditions, this would result in 36,000 x 6 = 216,000 bits or about 2×10^{5} bits. If this data enters AFGWC from 4 preprocessing sites, there would be about 8×10^{5} bits transmitted to AFGWC from the CONUS. This data should be sent in virtual real time for maximum utility; therefore, no more than one second should be allowed for the data from each processor site. This infers a 200 kilobit uplink capability to the communications satellite from each preprocessing station and a 200 kilobit downlink to AFGWC.

Note: Although reference 'a' indicated a requirement for archiving digital radar weather data, AFGWC has not indicated a requirement for this capability. Thus, archiving of such information has not been considered in this study.

Requirement No.: R410.2

Major Category: Environmental Support

Requirement Area: Digital Radar/RADAP NEXRAD Support

1.0 SUMMARY OF REQUIREMENT

Process data from RADAP system after 1980. The system will be installed incrementally during the period 1977-1980. The RADAP system will be incrementally replaced by NEXRAD in the mid to late 1980s.

2.0 RELATED OPERATIONAL FUNCTIONS

See R410.1.

3.0 COMM LINK INTERFACES

See R410.1.

4.0 REFERENCES

See R410.1.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

RADAP - National Weather Service Radar Digitization and Processing System
NEXRAD - National Weather Service Next Generation RADAR

6.0 DETAILED REQUIREMENTS

The "Digital Radar" paper (reference 'a' of R410.1) explicitly requires the processing of NWS data. However, in a memo to DO (reference 'b' of R410.1), it was stated that "No NWS documentation reflecting firm plans ... for a deployed digital weather radar which could provide data to AFGWC." Furthermore the requirement was not listed in the set of milestones set forth in the same memo.

The Draft ROC for WR 1980 (reference 'c' of R410.1) stated that due to the " ... close coordination between the NWS and AWS, the WR 1980 system will be installed in non-duplicating locations in the CONUS"; implying the AFGWC processing of NWS data. However, to avoid oversaturation of communications and processing capabilities, it must be assumed that NWS will not be inundating GWC with tremendous amounts of raw data, but rather that NWS will interface with the same preprocessing sites that will be handling the AWS data. Data rates listed under R410.1 include this NWS load.

See R410.1 for throughput requirements.

7.0 RELATED INFORMATION

None

Requirement No.: R410.3

Major Category: Environmental Support

Requirement Area: Digital Radar/Host Nations

1.0 SUMMARY OF REQUIREMENT

Incorporate into the AFGWC data base information received from host nation radar systems during the 1980s.

2.0 RELATED OPERATIONAL FUNCTIONS

See R410.1.

3.0 COMM LINK INTERFACES

See R410.1.

4.0 REFERENCES

See R410.1.

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

Japan, the United Kingdom and possibly Western European nations are expected to have at least a limited digital weather radar capability by the 1980s. Within communications limitations, AFGWC must be able to take advantage of the data produced by these systems. As each data source becomes available, it will be incorporated into the AFGWC data base and made available to relevant applications programs in the centralized production cycle.

7.0 RELATED INFORMATION

None

Requirement No.: R411.1

Major Category: Environmental Support

Requirement Area: Field Army (TESS) - Meso-Mesh Baroclinic Model Prognoses

1.0 SUMMARY OF REQUIREMENT

Provide ASL with forecasts produced by the Meso-Mesh Baroclinic Model. Required through FY 79.

2.0 RELATED OPERATIONAL FUNCTIONS

F2400 - Forecast/Prognosis Computations
F4100 - Software Development and Maintenance

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

No.	Title	Date
a. Letter DAMI-DOT-C	U.S. Army Atmospheric Sciences Laboratory Requirements for Prognostic Meteorological Information	6 Sep 74
b. Letter PRW	Same as above	27 Nov 74
c. ACN 18284(c)	Tactical Environmental Support System (TESS) Study (U), Dept. of Army, USA Training & Doctrine Command	Aug 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ASL - Atmospheric Sciences Lab. (U. S. Army)
TESS - Tactical Environmental Support System

6.0 DETAILED REQUIREMENTS

General

Meso-Mesh Baroclinic 11 x 11 Model 100 Prognoses; for the "Large ASL Window" which is defined as a grid between grid points, with corners at approximately (23N, 109W), (35N, 118W), (42N, 101W), and (28N, 96W). Wind components, temperature, and D-values are needed at each grid point for surface, 850, 700, 500, 300, 200, and 100 mb.

Frequency

Forecasts are needed every 12 hours giving parameters at two hour intervals out to 18 hours. This service would be required through fourth quarter FY 79.

Meso-Mesh Baroclinic Mode Prognoses (for a 11 x 11 grid and 100 nm spacing between grid points) requirements:

a. Software Development
   125 manhours programming
   50 CPU minutes (UNIVAC 1108) for testing
   30K core during testing
   10 minutes wall time per turnaround (50 turnarounds)

b. Production (2 runs per day)
   1 CPU (1108) mins/run
   30K core per run
   4 minutes wall time

7.0 RELATED INFORMATION

It is assumed that no automatic communications system is available.

Requirement No.: R411.2

Major Category: Environmental Support

Requirement Area: Field Army (TESS) - Cloud and Moisture Data Prognoses

1.0 SUMMARY OF REQUIREMENT

Provide ASL with forecasts on cloud and moisture on a demand basis to FY 79.

2.0 RELATED OPERATIONAL FUNCTIONS

See R411.1

3.0 COMM LINK INTERFACES

None

4.0 REFERENCES

See R411.1

5.0 RELATED ABBREVIATIONS AND ACRONYMS

See R411.1

6.0 DETAILED REQUIREMENTS

General

Cloud and Moisture Data Prognoses; for three and six hours giving percent cloudiness at each of the 15 height levels on the GWC eighth-mesh, and covering the ASL "Large Window" every three hours. These data would be required on a limited non-routine, non-interference basis from 3FY75 through 4FY79.

Frequency

Cloud and Moisture Data Prognoses:

a. Software Development: None

b. Production (8 runs per day)
   2 CPU mins (1110) per run
   65K core per run
   4 storage positions
   12 minutes wall time per run

Additional production to extract stored data are put on magnetic tape (4 runs/day)

1 CPU min/run
30K core per run
1-2 tapes per week
4 minutes wall time per run

7.0 RELATED INFORMATION

It is assumed that no automatic communications system is available.

The purpose of the TESS study was to determine the total impact of the environment on the tactical Army. This was accomplished by determining tactical Army environmental requirements/capabilities.

The study identified environmental parameters which significantly impact Army operations. These are primarily surface and low level (up to 800 meters) parameters. Products would usually be required to support operations in remote areas.

Thus the requirement would for AFGWC to provide mesoscale (much smaller scale than current capability) surface and low level products for areas with little or no surface reports available. This would make it essentially impossible to provide accurate products of the type required (e.g., seeability, height of inversion bases, refractive index, atmospheric motion (vorticity) prognoses, etc.).

Requirement No.: R412

Major Category: Environmental Support

Requirement Area: Weather Facsimile Switching System

1.0 SUMMARY OF REQUIREMENT

Obtain resources and equipment to replace the existing manual facsimile facilities at the Offutt Weather Communications Center (WCC) with a Weather Facsimile Switching Center (WFSC). The WFSC may consist of minicomputers and peripherals capable of providing more timely and efficient facsimile service to Air Weather Service (AWS) and its customers.

2.0 RELATED OPERATIONAL FUNCTIONS

F3200 - Facsimile Output Processing

3.0 COMM LINK INTERFACES

This requirement involves all current USAF facsimile networks - STRATFAX, EURFAX, PACFAX, AND RAFAX, and the Weather Graphics System replacement for EURFAX.

4.0 REFERENCES

	No.	Title	Date
a.	AFCS J-74-4	Offutt Weather Facsimile Switching Center (WSFC) Data Automation Requirement (DAR) [with 6 attachments]	—

5.0 RELATED ABBREVIATIONS AND ACRONYMS

WFSC - Weather Facsimile Switching Center (Offutt)
WCC - Weather Communications Center
KVDT - Keyboard Display Terminal

6.0 DETAILED REQUIREMENTS

To accommodate total automation from a centralized CONUS weather facsimile facility, AFGWC may use minicomputers (Interdata Model 50) of the same type that NWS is employing at the National Meteorological Center (NMC). The ID Model 50 will be hereafter referred to as the WFSC. The WFSC would replace the manual facility at Offutt AFB, Nebraska, and Suitland, Maryland. The WFSC would receive digitized weather facsimile maps from both the Suitland NMC and AFGWC. The maps/charts would be relayed to users on a predetermined schedule. The WFSC would be a store and forward system whose products would be received in digital form and converted to an analog signal compatible with customer facsimile recorders. A Keyboard Video Display Terminal (KVDT) would be used for monitoring system performance. It would allow operators to control and alter facsimile schedules. A teletype device would be used to provide a permanent record of data transmitted and received by the WFSC. An intermediate storage device (disk) could be used for map storage. The WFSC would also receive manually drawn charts. These charts would be digitized and stored on the intermediate storage device. A schedule of transmission requirements could be kept on the disk.

The transmission schedules would be executed automatically under program control. This would include all of the present manual management functions. The Interdata Model 50 installed at Suitland would be relocated to Offutt AFB WCC and would function as a program assembler and provide backup to the other two Model 50s.

7.0 RELATED INFORMATION

This system was requested for implementation by January 76.

It is assumed that this requirement can be supported with very little impact with the exception of slight additional main memory for buffering purposes.

Requirement No.: R414

Major Category: Environmental Support

Requirement Area: Weather Graphics System

1.0 SUMMARY OF REQUIREMENT

The Weather Graphics System (WGS) has been procurred as a replacement for the aging analog facsimile system in use throughout USAFE. The WGS will provide a significant increase in the AWS ability to provide graphical intelligence to users of environmental support throughout USAFE, and will completely eliminate EURFAX transmission from AFGWC.

2.0 RELATED OPERATIONAL FUNCTIONS

F3200 - Facsimile Output Processing (F3212: Manual EURFAX; F3222: Automatic EURFAX; F3215/3225: Weather Graphics System)

3.0 COMM LINK INTERFACES

Weather charts for the European Weather Graphics System will be transmitted from the Air Force Global Weather Central (AFGWC), Offutt AFB, Nebraska, via satellite to the Kindsbach Weather Relay Center (KWRC), Germany. The KWRC will (via regenerator/transmitter) relay weather charts to the European Weather Graphics System and on pre-arranged schedules originate and transmit weather charts to the European Weather Graphics System.

4.0 REFERENCES

(in AWS/SY Letter, "System Architecture Study")

	No.	Title	Date
a.	--	Weather Graphics System	--
b.	--	Background Paper, "Weather Graphics System"	21 Jan 75
c.	NR 74-2010-PC	Program Management Directive - WGS (Project 433L)	Nov 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

WGS - Weather Graphics System
KWRC - Kindsbach Weather Relay Center (Germany)
TWS - Tactical Weather System
SOON - Solar Observing Optical Network
TWR - Tactical Weather Radar
RSTN - Radio Solar Telescope Network

6.0 DETAILED REQUIREMENTS

The WGS is to be installed in 1975 and is expected to be operational in January 1976. AFGWC will drive the WGS with essentially the same product mix as today. The WGS digital transmitter will be located at AFGWC. By 1977, however, a modest increase in the number of products disseminated through the WGS can be expected (but not to exceed 200% of present volume). This system is expected to be in operation through 1982. At that time, it will be replaced by Modernized Base Weather Station equipment.

7.0 RELATED INFORMATION

It is assumed that EURFAX is eliminated as a result of this requirement. The impact is close to zero, in that the capabilities all exist, but may require more manual effort since more FAX charts may have to be drawn.

Requirement No.: R416

Major Category: Environmental Support

Requirement Area: Backup to Carswell

1.0 SUMMARY OF REQUIREMENT

Backup of the Carswell ADWS communications functions in 1982.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 Input Data Processing
F1200 Input Data Processing
F3000 Output Data Processing
F3400 Output Data Processing
F3600 Output Data Processing
F4520 Carswell Continuity of Operations Support

3.0 COMM LINK INTERFACES

AWN, Dedicated Circuits.

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (Tabs C, E, F, J.)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ADWS - Automated Data Weather Switch
NEDS - Navy Environmental Data Service
AFOS - Automation of Field Operations and Service

6.0 DETAILED REQUIREMENTS

AFGWC will assume backup of the Carswell ADWS communications functions in 1982. Functions include:

a. Data acquisition from overseas ADWS facilities.
b. Maintaining interfaces with other communication systems.
c. Support to MBWS automated functions -- to include data collection, dissemination and display.
d. To provide a total backup capability for Carswell, all input data communication sources to Carswell will be switchable to AFGWC.
e. Carswell data decoding and data processing computer programs will be available at AFGWC for operation on AFGWC computers.

7.0 RELATED INFORMATION

a. The missions of the automated Weather Network (AWN) are: (1) to acquire and transport Sino Soviet weather data to AFGWC and (2) to acquire, process and distribute weather data to various DOD agencies. Carswell Air Force Base is the present site for collecting, processing and distributing AWN data and products.

b. In the event of a loss of the Carswell facility, overseas AWN data cannot be supplied to AFGWC because (1) there is no direct communication links between AFGWC and the overseas data sources and (2) AFGWC does not have the decoder programs to process data directly from the overseas facilities.

c. Current AWN data supplied to AFGWC by Carswell represents only 26% of the daily data output at Carswell. The other 74% is supplied to various DOD customers.

d. Carswell Data Sources

Source	Bits/Day
Croughton (England)	48.6×10^6
NWS (Suitland)	34.4×10^6
Fuchu AFB	15.7×10^6
Clark AFB	19.3×10^6
FAA (WMSC)	9.7×10^6
RAWARC	7.2×10^6
Hawaii	1.9×10^6
Pan Am	1.6×10^6
Nandl, Flgl	1.6×10^6
Miami HC	1.3×10^6
Comet I	0.9×10^6
Alaska	0.9×10^6
Autodin	0.9×10^6
AFTN	0.5×10^6
Comet II	0.5×10^6
ATN	0.4×10^6
South America	0.2×10^6

e. Carswell Customers

Source	Bits/Day
AFGWC	105.5×10^6
NWS	50.4×10^6
FLENUMWEACEN	50.4×10^6
Comet III	48.9×10^6
Croughton	34.2×10^6
Comet II	18.0×10^6
AFTAC	14.4×10^6
Fuchu	11.9×10^6
Fleet Bdests	11.9×10^6
Clark	11.9×10^6
Comet I	5.8×10^6
TAC FC	5.8×10^6
Cheyenne Mt	5.4×10^6
N. Atlantic	3.9×10^6
Hawaii	3.4×10^6
Alaska	3.1×10^6
Howard/GTMO	2.5×10^6
Bermuda	2.2×10^6
FAA (WMSC)	1.8×10^6
AGTN	1.4×10^6

See white paper R416.

Requirement No.: R417

Major Category: Environmental Support

Requirement Area: ETAC Backup Support

1.0 SUMMARY OF REQUIREMENT

By 1982 AFGWC will provide the capability to assume, on a degraded basis, the operational functions of the USAF Environmental Technical Applications Center (ETAC) whenever the ETAC facility becomes inoperative for longer than a twelve hour period. For periods of ETAC outage of more than twelve hours, AFGWC will maintain a 6-12 hour ETAC data base and will accumulate and store five consecutive days of this data base throughout the period of ETAC outage. In addition, AFGWC shall be capable of providing a 90-day archive of processed historical weather data to ETAC in the event that the ETAC outage is of a duration which prevents ETAC from reconstructing the data required to produce a 3 month weather history report.

2.0 RELATED OPERATIONAL FUNCTIONS

F1400 - Product Requests
F2200 - Data Base (Analysis) Computations
F3600 - Dedicated Circuit Outputs
F3800 - Special Projects Outputs
F4500 - ETAC Continuity of Operations Support

3.0 COMM LINK INTERFACE

Dedicated ARPA Network Circuit with upgrade to Autodin II (WWMCCS) circuit.

4.0 REFERENCES

No.	Title	Date
a. AWS/SY letter	AFGWC System Architecture Study (Tab A, C, J)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

USAF ETAC - USAF Environmental Technical Applications Center
WIN - WWMCCS Intercomputer Network

6.0 DETAILED REQUIREMENTS

To meet the ETAC Continuity of Operations backup requirement, AFGWC will be required to perform the following activities whenever the ETAC facility is inoperative for more than 12 hours:

a. Maintain a 6 to 12 hour old data base whose context is equivalent to the ETAC climatological data base.

b. Initiate procedures for accumulating and storing historical weather data for five consecutive days commencing 12 hours after ETAC has become inoperative. This activity is to allow ETAC to reconstruct their data base when they become operational.

c. Initiate the procedures for processing and storing, on magnetic tape, data for a 90-day archive of weather history. This activity is to assure the availability of data for a 90-day ETAC weather report in the event the ETAC facility is inoperative for five days or more. It will require AFGWC to operate on its computers, programs equivalent to the current ETAC SPECTRA 70/45 and IBM 360-44 programs. If the ETAC facility is inoperative for a full 90-day period, AFGWC must provide a tape storage capacity for $1,3365.5 \times 10^6$ 36-bit words.

d. Provide data as follows:

1. Summarized data for JOPS
2. Climo wind input to SIOP
3. Worldwide airfield summaries
4. Clear line of sight/cloud free line of sight probabilities
5. Worldwide cloud cover statistics
6. Moonrise/Moonset - illumination
7. Sunrise/sunset - daylight/darkness calculations
8. Solar geophysical historical information
9. Diffusion information
10. Comfort/human stress factors
11. Tide, wave, storm (oceanic) summaries

e. Provide historical daily weather summaries

7.0 RELATED INFORMATION

a. To meet the ETAC backup requirement as defined, the following scenario has been recommended:

1. AFGWC will provide continuous storage of the ETAC climatological data base.

2. A dedicated communication link will be established between ETAC and AFGWC.

3. ETAC, when operational, will update the AFGWC stored ETAC data base via a dedicated communications link.

4. ETAC will provide to AFGWC the operational computer programs required by AFGWC to maintain and update the ETAC data base during those periods of contingency support.

5. AFGWC will provide a backup capability to ETAC on the following basis:

   a) No support will be provided for periods of outage of 12 hours or less.

   b) For periods of outage of more than 12 hours, AFGWC will maintain a 6-12 hour old data base and will accumulate and store historical weather data for the preceeding five days. The accumulation and storage of five-day historical data will be initiated 12 hours after ETAC has been inoperative.

   c) AFGWC will provide a 90-day archive of weather data for backup of the ETAC system.

b. The basic function of ETAC is to provide historical weather data to DOD and civil agencies. ETAC's primary product is a 90 day summary of weather data which the facility produces every three months. Historical weather data is also provided on an as requested basis for specific customers.

   USAF ETAC is currently located at the NWC in Suitland, Md. ETAC data processing facilities consist of one SPECTRA 70/45 and one IBM 360-44.

1.5 SPACE SYSTEMS AND SPACE ENVIRONMENT SUPPORT REQUIREMENTS

Requirement No.: R501.1

Major Category: Space Systems and Space Environment Support

Requirement Area: NORAD/ADC - Satellite Support

1.0 SUMMARY OF REQUIREMENT

Generation of alerts and predictions of partical fluxes and density variations at satellite altitudes that would adversely affect satellite ephemerides and health.

Capability required by late 1970s.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100, F1330 - SESS and METSAT/Imagery Secondary Sensor Input Data Processing
F2100 - SESS Computations
F3100 - SESS Output Data Processing

3.0 COMM LINK INTERFACES

Autodin, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D, Attachment 4b)	25 Feb 75
b.	ADC ROC 10-74(S)	Required Operational Capability for a Space Defense System. (AWS/DNT files)	1 Nov 74
c.	ADC ROC 1-75(S)	Required Operational Capability on Improved Space Surveillance (AWS/DNT files)	24 Jan 75
d.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ARONYMS

None.

6.0 DETAILED REQUIREMENTS

Specific detailed requirements for NORAD/ADC are not defined in the available references 'a' and 'b'. However, they are referenced as general requirements in paragraph 'd', section 3 of TAB VI of Data Automation Requirement, AFGWC Computer Upgrade (ref. 'b'). These general requirements call for the operations of Data Base building and SESS application programs at intervals of one to three hours to produce products to support NORAD's Satellite Early Warning System.

7.0 RELATED INFORMATION

The general requirements can be supported. The problem has to do with the model that needs to be updated at NORAD. The SFD sensor will be flown during the time period of DMSP to collect neutral density. The reduction of this model will be a new requirement. Telecon with Major Upchurch, 2 May 75, indicates that a modular neutral-density model for once per day update should be considered. For the future neutral-density model, SDC assumes 100K main memory requirement, 15 minute CPU time, storage of 200K words.

See Requirement R501.3, Volume 3, for classified support requirements.

Requirement No.: R501.2

Major Category: Space Systems and Space Environment Support

Requirement Area: NORAD/ADC - SPADATS Support

1.0 SUMMARY OF REQUIREMENT

Provide predictions of electron-density profiles on tailored range-correction tables for SPADATS satellite tracking radars.

Required late 1970's.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - SESS Input Data Processing
F2110 - SESS Computations
F3100 - SESS Output Data Processing

3.0 COMM LINK INTERFACES

AUTODIN, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D, Attachment 4b)	25 Feb 75
b.	ADC ROC 10-74(S)	Required Operational Capability for a Space Defense System. (AWS/DNT files)	1 Nov 74
c.	ADC ROC 1-75(S)	Required Operational Capability on Improved Space Surveillance (AWS/DNT files)	24 Jan 75
d.	AWS/SY Letter	DAR, AFGWC Computer Upgrade	10 Jan 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

Requires forecast of electron-density profiles at each of six sites, issued once per day. Currently requires real-time ionospheric forecast fields on Systems I/II/IV. Estimate 40K, 10 minutes CPU per day.

7.0 RELATED INFORMATION

See Requirement R501.3, Volume 3, for classified support requirements.

Requirement No.: R502

Major Category: Space Systems and Space Environmental Support

Requirement Area: NASA Space Shuttle

1.0 SUMMARY OF REQUIREMENT

When the Air Force is tasked for operational support to the NASA Space Shuttle Systems, natural environmental support will be required from the AFGWC for orbiter ferry flights, launch to orbit operations and/or for deorbit, entry and landing. Space environmental data and forecasts will also be required in support of space operations.

2.0 RELATED OPERATIONAL FUNCTIONS

F1400 - Product Requests Input Data Processing
F2200 - Request Processing Computations
F3100, F3500 (and/or F3600) - Space Environmental Products, AUTODIN Products (and/or Dedicated Circuits) Output Processing

3.0 COMM LINK INTERFACES

ATN, AUTODIN (and/or Dedicated Circuits)

4.0 REFERENCES

	No.	Title	Date
a.	NASA TM X-64864	Natural Environmental Support Guidelines for Space Shuttle Tests and Operations	Jul 74
b.	AWS/DNPS Letter	AFGWC Systems Architecture Study	8 Oct 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

ATN - Astrogeophysical Teletype Network

6.0 DETAILED REQUIREMENTS

Environmental support requirements have been defined as follows for NASA Space Shuttle operations:

a. Prelaunch and Launch to Orbit

1. Observed and predicted profiles of wind temperature and moisture for support to each phase of operations.
2. Severe weather monitoring (and forecasts).

b. Orbit Maneuvers and Operations

1. Observations and forecasts of solar activity
2. Observations and Forecasts of energetic particles (high energy protons and secondary neutrons and protons).
3. Expected variation in density at orbital altitude.

c. Deorbit, Entry, and Landing

1. Density profiles from 400,000 feet (122KM) for entry area.
2. Wind profiles from 80,000 feet (24KM) in entry area.
3. Prediction of weather hazards near surface in entry area.

d. Orbiter Ferry Flights

1. Enroute flight forecasts for ferry flights.
2. Flight following.
3. Terminal forecasts for ferry operations.

7.0 RELATED INFORMATION

If NASA tasks the Air Force to support Space Shuttle operations, requirements for environmental support will not change. For the purposes of the architecture study, it is assumed that only launch support will be required.

Requirement No.: R504

Major Category: Space Systems and Space Environment Support

Requirement Area: AFETR

1.0 SUMMARY OF REQUIREMENT

To provide HF propagation forecasts for special circuits (in addition to current support of AFETR point to point HF radio circuits).

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - Space Environmental Data Input Data Processing
F2102 - HF Propagation Data Base and Related Computations
F3100 - SESS Products Output Processing

3.0 COMM LINK INTERFACES

ATN, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AFSC Letter	High Frequency (HF) Radio Propagation Forecast	27 Aug 73
b.	AWS/SY Letter	AFGWC Systems Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

AFETR - Air Force Eastern Test Range
SES - Space Environment Support
ATN - Astrogeophysical Teletype Network

6.0 DETAILED REQUIREMENTS

There are an average of 5 requests per month with two weeks notice. Information to produce forecast will be provided.

It is assumed that this support will be minimal and is basically sized under R506 (AFCS).

7.0 RELATED INFORMATION

None

Requirement No.: R505

Major Category: Space Systems and Space Environment Support

Requirement Area: AFWTR

1.0 SUMMARY OF REQUIREMENT

To provide data to determine ionospheric refraction associated with RF transmission involved in a range rate tracking technique for launches.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - Space Environmental Data Input Data Processing
F2102 - HF Propagation Data Base and Related Computations
F3100 - SES Products Output Processing

3.0 COMM LINK INTERFACES

ATN, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	XREA Letter	Ionospheric Data Electron Density Profiles	23 Jan 75
b.	AWS/SY Letter	AFGWC Systems Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

AFWTR - Air Force Western Test Range
SES - Space Environmental Support
ATN - Astrogeophysical Teletype Network

6.0 DETAILED REQUIREMENTS

To determine S-band refractive indices based on electron density profile data. The changeability of the data will depend on how often the data need be supplied. The amount of data and the computation required will be minimal (a few minutes of CPU time and a message transmitted less than once per day.) The AFGWC data base currently contains the electron density data required.

7.0 RELATED INFORMATION

This requirement is minimal, requiring only a few minutes of CPU time.

Requirement No.: R506

Major Category: Space Systems and Space Environment Support

Requirement Area: Air Force Communications Service (AFCS)

1.0 SUMMARY OF REQUIREMENT

Provides climatological predictions and analyses of global HF propagation conditions. This requirement pertains to the assignment of frequencies based on analysis using the ionospheric model.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - SESS Input Data Processing
F2110 - SESS Computations
F3100 - SESS Output Data Processing

3.0 COMM LINK INTERFACES

ATN, Dedicated Circuits

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC Systems Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

Avg 1560 paths/month
Avg 8 hours CPU/month (65K)
Peak - 7000 paths/month
Peak - 35 hrs CPU/month

See R512 for real-time frequency management

7.0 RELATED INFORMATION

It is assumed that a new model will be built in order to handle this requirement.

Requirement No.: R508

Major Category: Space Systems and Space Environment Support

Requirement Area: AFSATCOM

1.0 SUMMARY OF REQUIREMENT

a. Provide Solar Geophysical alerts and predictions of periods of high energy particle enhancements that affect the health of satellites. Provide predictions of occurrence of ionospheric scintillation that would affect AFSATCOM or AFSATCOM II.

b. Provide support for ionospheric and atmospheric effects on UHF (240-400 MHz) communications through the AFSATCOM satellites.

Needed for AFSATCOM by late 1977 (testing beginning in 1975).
Needed for AFSATCOM II by 1982.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - SESS Input Data Processing
F2110 - SESS Computations
F3100 - SESS Output Data Processing

3.0 COMM LINK INTERFACES

SIOP CINC's.

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D, Attachment 4a)	25 Feb 75
b.	---	Hq USAF PMD No. R-S 2-053-(6)(5)	11 Nov 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

SIOP CINC's - CINCSAC, CINCEUR, CINCPAC, CINCLANT, CINCNDRAD

6.0 DETAILED REQUIREMENTS

As detailed in 1.0.

7.0 RELATED INFORMATION

None.

Requirement No.: R509

Major Category: Space Systems and Space Environment Support

Requirement Area: Army Safeguard

1.0 SUMMARY OF REQUIREMENT

There is an operational requirement for range error correction data in support of the SAFEGUARD requirement.

2.0 RELATED OPERATIONAL FUNCTIONS

F1420 - Command and Control Systems Input Data Processing
F2100, F2200 - SES Computations and Request Processing Computations
F3100 - SESS Products Output Processing

3.0 COMM LINK INTERFACES

WIN, Dedicated Circuits

4.0 REFERENCES

None

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

There has currently been no tasking associated with the requirement, although it is anticipated that support will be required. This minimal impact requirement will not be of enough significance to consider in this study.

7.0 RELATED INFORMATION

See 6.0 above.

Requirement No.: R510

Major Category: Space Systems and Space Environment Support

Requirement Area: Air Force Space Transportation System (STS)

1.0 SUMMARY OF REQUIREMENT

Computerized flight plans for the flight paths of ferry operations and deorbiting. Major items of interest will be forecasting of icing and turbulence along the flight path.

2.0 RELATED OPERATIONAL FUNCTIONS

F1430 - Miscellaneous Input Request Processing
F2200 - Request Processing Computations

3.0 COMM LINK INTERFACES

Comm link interfaces have not been defined.

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D, Attachment 3k)	25 Feb 75

This includes NASA Technical Memorandum TM-X-64864, "Natural Environment Support Guidelines for Space Shuttle Tests and Operations".

5.0 RELATED ABBREVIATIONS AND ACRONYMS

List of abbreviations, acronyms, and symbols are defined in page viii of NASA TM X-64864.

6.0 DETAILED REQUIREMENTS (From NASA TM X-64864, July 1974[1])

a. Establishment of a procedure to identify, monitor and predict thunderstorm activity along the space shuttle flight path. (Length of the forecast is important.)

b. Possible requirement for real-time transmission of wind profile information below 80,000 feet altitude along a specific flight path.

c. Prelaunch observations, predictions and real-time monitoring using existing support technology and capabilities.

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[1]A reasonable discussion of all Natural Environment Support planned for space shuttle tests and operations is presented in the referenced document. However, the specific amount of data and processing required must be inferred.

d. Natural Environment Requirements are defined in a summary chart on page XV of NASA TM X-64864.

e. Test vehicles will be utilized in the time period 1977 to 1980, with an operational system scheduled for 1980. Environment Support will be initially required for 1977.

7.0 RELATED INFORMATION

It is assumed that the only support will be launch and recovery. All the basic elements for support are available in the data base. The messages will be small. There will be very high reliability associated with this support. Additional required information includes:

a. The proposed method of communicating GWC data to the space transportation system.

b. Estimates of the AFGWC processing loading required to meet the STS needs.

c. Weather information at STS launch and recovery points and their capability to supply inputs to the GWC in order to provide the required support.

Requirement No.: R511.1

Major Category: Space Systems and Space Environment Support

Requirement Area: Over the Horizon Radar Systems (OTHB)

1.0 SUMMARY OF REQUIREMENT

To support the 414L-PRS by providing environment support of the propagation characteristics of the Ionosphere.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - SESS Input Data Processing
F2110 - SESS Computations
F3100 - SESS Output Data Processing

3.0 COMM LINK INTERFACES

See 6.0 below.

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab D, Attachment 3a) (includes) a background paper and a briefing for CONUS by Major Ramsay of AFGWC)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

CTWG - Combined Test Working Group
PRS - Prototype Radar System
DSARC- Defense Systems Acquisitions Review Concil

6.0 DETAILED REQUIREMENTS

Assume routine transmission of F3110, F3120, F3130 products. Assume transmission of F2110 analysis fields every two hours. Requires 40K, 5 minutes CPU, 200K words of mass storage:

Extract from a Briefing by Major Ramsay (AFGWC)

Ionospheric Support

We can normally classify customer support in three categories: forecasts, alerts, and analyses. We anticipate that the general character of the PRS support will be very similar to that being provided to operational customers today.

We expect to provide FORECASTS of usable frequencies, probable propagation modes, geomagnetic storms, short-wave fades, and polar cap absorption events. Services will probably also include predictions of the position of the auroral oval. Forecasters at the AFGWC will monitor the state of the ionosphere, and will provide near real-time updates and amendments to forecasts that "bust".

In addition, we will provide reliable and responsive real-time alerts of the imminent onset or actual occurrence of significant events that will impact PRS operations: events such as geomagnetic storms, short wave fades, or polar cap absorptions.

Finally, we will support PRS analysis activities by providing detailed specification of usable frequencies, propagation modes, and electron density distribution over the coverage area.

A key point must be made here: The format and content of these support elements have not been specified. We will have to consider the sensitivity of the system to the various environmental parameters in order to establish the frequency, timeliness, granularity, and accuracy of each type of service needed to meet the requirements of the PRS.

Environmental Models

Air Weather Service will plan to have state-of-the-art models in a fully operational status. We cannot say with any degree of certainty that the state-of-the-art in ionospheric analysis or forecasting will satisfy the accuracy requirements of the PRS. Even though the precise requirements have not yet been specified, we must admit to a significant degree of pessimism, especially with regard to the high degree of spatial and temporal variability in the high latitude ionosphere.

Centralized Processing Facility - AFGWC

Certain types of support can easily be provided with current resources. However, the more complex products, including tailored forecasts of usable frequencies and detailed specification of electron-density distribution, will require a computer upgrade at the Global Weather Central. Although we have an operational ionospheric-analysis capability at AFGWC now, our hardware is not configured to allow us to communicate directly with our customers -- security restrictions prevent us from transmitting data or analysis fields from the particular processing unit used for automated analysis. AFGWC has requested a computer hardware upgrade that will provide adequate analysis capability in a processing unit configured for direct communication with customers via dedicated line, AUTODIN, or common-user low-speed teletype. The upgrade is in no way "tied" to PRS support. We expect to have the upgrade capability in operation during CY77. You should be aware that if the upgrade is not approved, or if the IOC slips into CY78, we will not be able to provide detailed ionospheric forecasts or analyses on a routine, timely basis. We expect to be able to perform a delayed post-analysis function if the number of analyses is not large. We should emphasize that real-time alerts of significant distruptive events will be available regardless of the status of the computer upgrade.

Communications

Communications may pose a significant problem. It may be necessary to establish dedicated communications between the AF Global Weather Central and either the PRS or the analysis site. It is NOT our policy to dump our data base on our customers. We plan to provide support that is tailored specifically to the needs of the system. However, if the system operators or analysts identify a need for a great number of specific observations in real time or for automated analyses of F-region critical frequencies, we will have to transmit large volumes of data at routine intervals. Line costs could run from $700-$1000 a month for a dedicated circuit.

There are additional communication problems associated with actually gathering the observational data which may be required for support to the PRS.

Observing Network

We agree completely with the Air Force Cambridge Research Laboratories that the PRS test should have the most complete environmental data base possible. We've investigated data sources throughout the coverage area, and we've found that some extreme costs will probably require a careful selection of real-time and delayed data for post analysis. We have detailed cost estimates available, but I can summarize by saying that real-time acquisition of full time observations from the AFCRL Goose Bay geophysical observatory, hourly observations from ionosondes at Narssarssuaq, Godhavn, and Keflavik, and hourly observations from riometers at Godhavn, Godhaab, and Narssarssuaq would cost something over $600,000 for one year. A reduced data set (for example, full observations from Goose Bay in real time, with a 2-4 day delay in data from Narssarssuaq, Godhavn, Keflavik, and St Johns (Newfoundland) could be obtained for about $200-300,000 per year. We feel that an optimized data set can be specified with the assistance of AFCRL, and that costs can be kept to a reasonable level.

A firm belief that a proper assessment and analysis of the environment will be a critical factor in the success (or failure) of the PRS. It would have been difficult to select a more hazardous environment in which to test the OTH-B concept. The extremely dynamic nature of the high-latitude ionosphere and its relation to the PRS coverage area will present a real challange to the system designers, operators, and analysts. Air Weather Service recognizes its responsibility to provide state-of-the-art environmental support, and we will certainly provide all the support possible with the resources available.

7.0 RELATED INFORMATION

System checkout will begin May 1977. System performance test will begin Dec 1977. Initial checkout of the OTH-PRS will start approximately April 1978. AFGWC support should be available at that time.

See white paper R511. See Requirement R511.2, Volume 3, for classified support requirements.

Requirement No.: R512

Major Category: Space System and Space Environment Support

Requirement Area: Tactical Frequency Management

1.0 SUMMARY OF REQUIREMENT

To continually monitor and model the propagation conditions in a tactical theatre to determine spectrum usage.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - Space Environmental Data Input Data Processing
F2100 - SESS Computations
F3100 - SESS Products Output Processing

3.0 COMM LINK INTERFACES

See section 6.0 and 7.0 below.

4.0 REFERENCES

	No.	Title	Date
a.	FAC ROL 324-74	Tactical Frequency Management System	14 Dec 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

TFMS - Tactical Frequency Management System
SID - Sudden Ionospheric Disturbances

6.0 DETAILED REQUIREMENTS

Ionospheric sounding data is utilized to identify sudden ionospheric disturbances, ionospheric tilt, sporadic E which can affect HF communication. Conceivably the message would be generated only on request, apply to anywhere in the world (might be closely linked to SEEK BUS). Required information includes request response time, amount of data to be provided, link, and how long the data will be valid.

7.0 RELATED INFORMATION

This requirement might be closely linked to SEEK BUS.

Requirement No.: R513

Major Category: Space System and Space Environment Support

Requirement Area: High Frequency Propagation Forecast for Computer Flight Plans

1.0 SUMMARY OF REQUIREMENT

To provide a worldwide capability for calculation of optimum frequencies for air-ground HF communications.

2.0 RELATED OPERATIONAL FUNCTIONS

F1400 - Product Requests Processing
F2100 - SESS Computations
F3500 - AUTODIN Products Output Processing

3.0 COMM LINK INTERFACES

AUTODIN

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None.

6.0 DETAILED REQUIREMENTS

A maximum of 60 minutes of computer time per day should be allocated to this program.

7.0 RELATED INFORMATION

This requirement will be considered.

See white paper R513.

Requirement No.: R519

Major Category: Space Systems and Space Environment Support

Requirement Area: Global Positioning Satellite (GPS)

1.0 SUMMARY OF REQUIREMENT

To provide satellite users with ionospheric data to assist in geopositioning.

2.0 RELATED OPERATIONAL FUNCTIONS

F1100 - Space Environmental Data Input Data Processing
F2100 - SESS Computations
F3100 - SESS Products Output Processing

3.0 COMM LINK INTERFACES

TBD - see section 6.0 and 7.0 below.

4.0 REFERENCES

None

5.0 RELATED ABBREVIATIONS AND ACRONYMS

GPS - Global Positioning Satellite
SES - Space Environmental Support

6.0 DETAILED REQUIREMENTS

Due to the dual frequency capability which will be applied to most important military applications, no support will be required. There may, however, be some single frequency customers that require support.

7.0 RELATED INFORMATION

This requirement will not be considered.

See white paper R519.

1.6 GENERAL REQUIREMENTS

Requirement No.: R601

Major Category: General

Requirement Area: Growth

1.0 SUMMARY OF REQUIREMENT

In order for AFGWC to meet unanticipated requirements, it is necessary that the new AFGWC architecture can maintain adequate margins for growth and expansion.

2.0 RELATED OPERATIONAL FUNCTIONS

All

3.0 COMM LINK INTERFACES

All

4.0 REFERENCES

No.	Title	Date
a. AWS/SY Letter	AFGWC System Architecture Study (Tab k, Attachment 3)	25 Feb 75

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

It is essential to develop an AFGWC production system which has potential to accommodate inaccuracies in sizing requirements for the 77-82 time frame. A 5% "buffer" throughout the 77-82 period should be adequate for this purpose. Furthermore, the system should be designed in such a way that it has continued growth potential for the years 1982 through 1986. Based on historical data, AFGWC computational capacity has had a growth rate in excess of 30% during the past ten years. For the 1982-1986 period, system capacity should be expandable by 20% per year; i.e., it should be able to grow to 2.5 times the capacity of the 1982 system with little impact.

This requirement should apply to all major components of the data system, i.e., leaving a 20% annual margin for CPU speeds may not lead to a 20% annual increase in overall productivity if I/O operations are constrained by channel rates. Thus, in the post-82 time period, appropriate annual growth margin should be available as necessary for:

a. Equivalent central processing units speeds;
b. Main memory capacities and cycle times;
c. Auxiliary storage capacities and transfer rates;

d. I/O and communication channel rates;
e. Flexibility in accommodating greater numbers of peripheral devices, such as printers, CRTs, and communications terminals.

7.0 RELATED INFORMATION

The above has been summarized in white paper R601.

Requirement No.: R602

Major Category: General

Requirement Area: Manpower Productivity

1.0 SUMMARY OF REQUIREMENT

AFGWC has growth rapidly during the past five years, reaching an authorized UDL strength of 757 spaces in FY75. This manpower is essential today to perform the assigned mission. However, only 718 spaces are authorized by the MACMET study. Currently, 676 personnel are assigned to AFGWC. At the same time, it is recognized that many of the tasks performed are not fully exploiting available automation, display and communication technologies. It is essential to increase the productivity of AFGWC manpower.

2.0 RELATED OPERATIONAL FUNCTIONS

All (Primarily the Data Base Computation Area, F2000)

3.0 COMM LINK INTERFACES

All

4.0 REFERENCES

	No.	Title	Date
a.	AWS/SY Letter	AFGWC System Architecture Study (Tab I)	25 Feb 75
b.	--	Statistical Standards Proposal by MACMET, Scott AFB	2 Sep 74

5.0 RELATED ABBREVIATIONS AND ACRONYMS

None

6.0 DETAILED REQUIREMENTS

Future Plans: Manpower resources with USAF are expected to decrease in the 1977-1982 time frame. Thus, every effort must be made to accomplish the new tasks addressed in this study without a significant increase in AFGWC manpower. A concerted effort must be made to increase productivity, making spaces available for tradeoff against equipment enhancements.

7.0 RELATED INFORMATION

The following functions should be prime candidates for increased productivity:

a. Computer operators/tape handlers
b. Programmers, both applications and development
c. Observers - primarily in the WPF work centers
d. Forecasters - primarily in the WPF work centers

1.7 USER REQUIREMENT/FUNCTION RELATIONSHIPS

REQUIREMENTS

FUNCTIONS		SPECIAL ACTIVITIES 1 0 0123456789	SPECIAL ACTIVITIES 1 1 0123456789	SPECIAL ACTIVITIES 1 2 0123456789	COMMAND CONTROL 2 0 0123456789	COMMAND CONTROL 2 1 012345678	EWO 3 0 012345	ENVIRON. SUPPORT 4 0 0123456789	ENVIRON. SUPPORT 4 1 01234567	SESS 5 0 0123456789	SESS 5 1 0123456789	GEN. 6 0 012
SESS	1100											
	1110											
	11							X	X			
	12											
	13							X				
	14										X	
	1120											
	21										X	
	22											
	23			X								
	24											
	25										X	
CONVENTIONAL OATA	1200											
	1210							X				
	11							X	X			
	12							X				
	13							X	X			
	1220							X				
	21							X				
	22							X				
	23							X				
	24							X				
	25							X				
	1230											
	31											
	32							X				
	33											
	34								X			
METSAT/IMAGERY OATA	1300											
	1310											
	11			X								
	12											
	13			X								
	1320											
	21											
	22											
	23											
	1330											
	31											
	32											
	33											
	34											
PROOUCT REQUESTS	1400											
	1410				X X X X X X		XXX					
	11				X X X X X X		XXX					
	12				X X XX XXXX XXX X		XXX					
	13				X X XX XXXX XXX X		XXX					
	1420				XXXXXXXXXXXXXXXXX		XXXXX					
	21											
	22				X		X X					
	23				XX X X X X		XXXXX					
	24				XXX XXXXXXXXX		XXXXX					
	1430				X X X X X		XXXXX					
	31				X X		X X					
	32				X		X					
	33				X X X X X		XX					
	34	XXX X XXX	X	X	XXXX X X X		XX					
	35						X					
	36							X				
OIGITAL RADAR	1500								X			
SPECIAL PROJECTS	1600	XXXXXXXXXXX XX XXXX		XX X					X		X X	

Figure 2. AFGWC Requirement/Input Processing Functions Correlation.

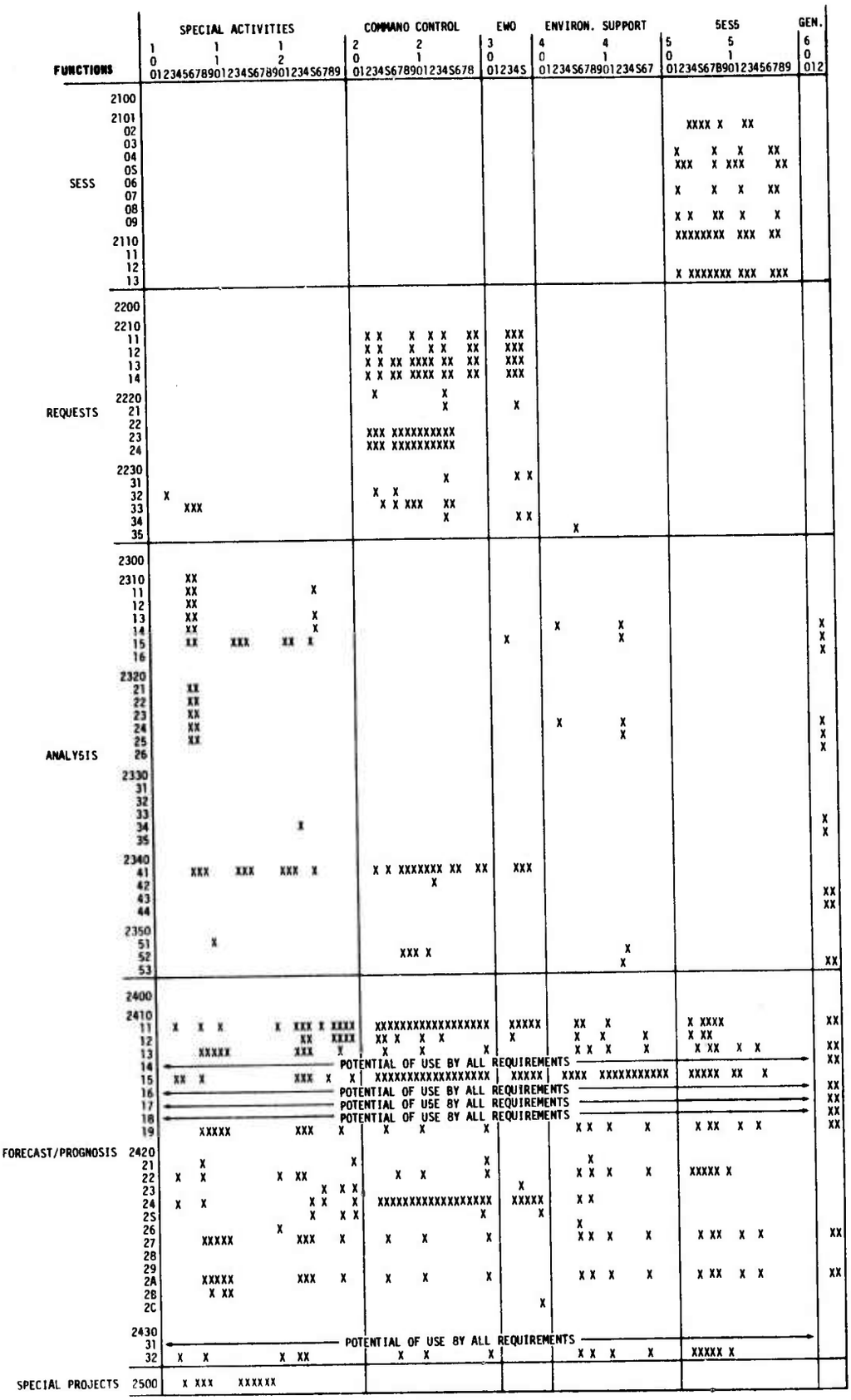


Figure 3. AFGWC Requirements/Computation Functions Correlation

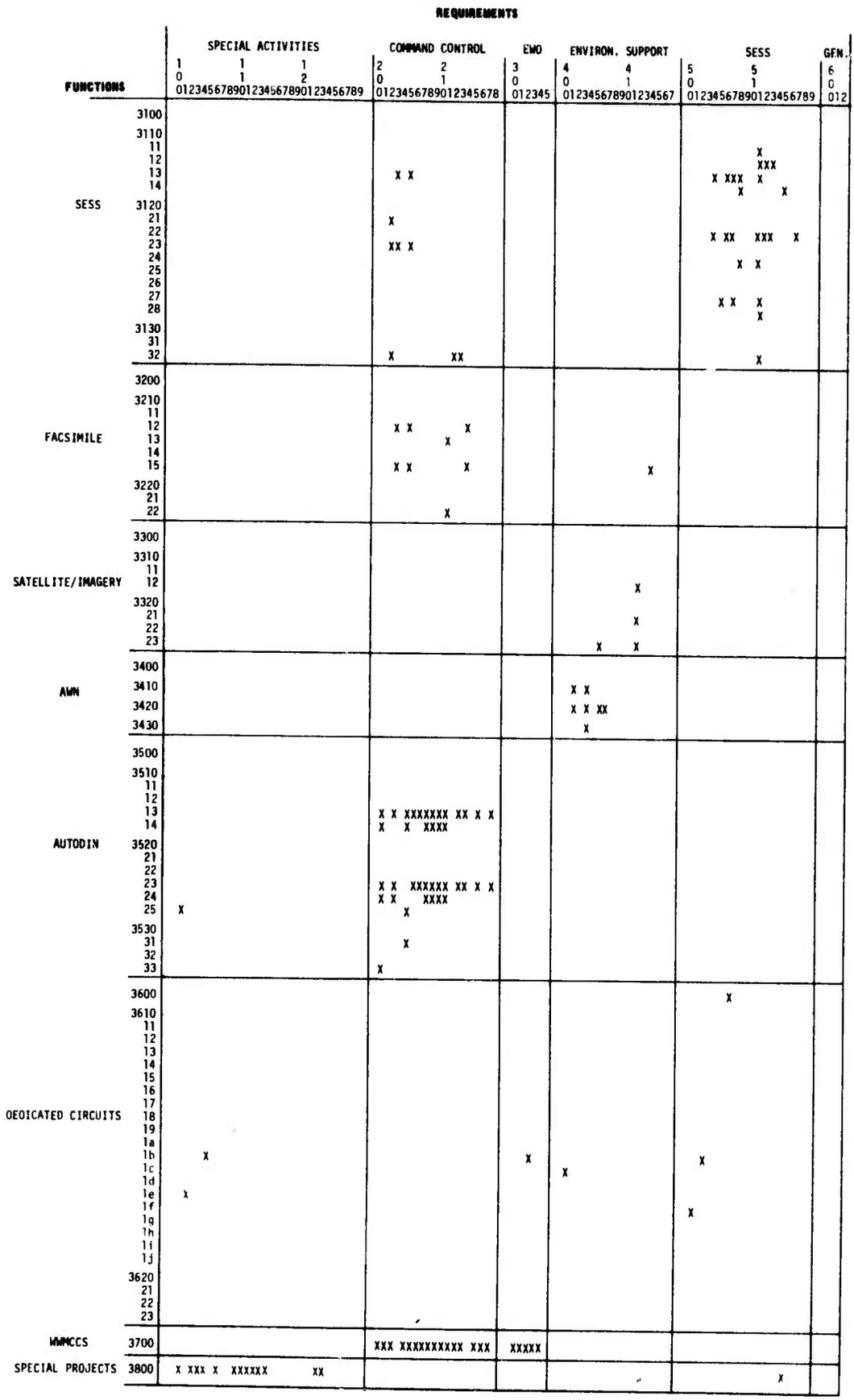


Figure 4. AFGWC Requirements/Output Processing Functions Correlation.

REQUIREMENTS

FUNCTIONS		SPECIAL ACTIVITIES	COMMAND CONTROL	EWO	ENVIRON. SUPPORT	SESS	GEN.
		1 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9	2 2 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8	3 0 1 2 3 4 5	4 4 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7	5 5 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9	6 0 1 2
SOFTWARE DEV./MAINT.	4100						
	4110						
	4120						
	4130						
SPCL. STUDIES	4200						
	4210						
	4220						
	4230						
	4240						
SYSTEM MGT.	4300						
	4310						
	4320						
	4330						
	4340						
COMPUTER OPS.	4400						
	4410						
	4420						
	4430						
	4440						
	4450						
	4460						
	4470						
	4480						
	4490						
CONTINUITY OF OPERATIONS	4500						
	4510						
	11				X		
	12				X		
	13				X		
	4520						
	21				X		
	22				X		
	4530						
	31				X		
	32				X		
	4540						
	41				X		
	42				X		
DATA BASE	4600						
	4610						
	4620						
	21						
	22						
	4630						
	31						
	32		X				
	33						
	34						
	35					X	
	36	X X XXXXX					
	4640						

Figure 5. AFGWC Requirements/Support Processing Functions Correlation.

2.0 MODEL REQUIREMENTS

This section summarizes the new model requirements as initially generated by the Studies and Analysis staff of AFGWC, and as subsequently augmented by inputs from other personnel at AFGWC, AWS, and SAMSO. These new models are planned for implementation over the 1977-82 time period, and are listed on a year-by-year basis. A summary of model analyses is presented in Table 3, followed by detailed analyses of the 38 model projects considered in this architectural study. Included in these detailed analyses are pertinent white papers that indicate the dispositions of models not considered as significant for the purposes of this study.

TABLE 3

ADVANCED MODELS SUMMARY

LEGEND:

KEY - Key Driving Requirement
NC - No Change
LI - Little Impact
X - Included as Requirement

	MODEL	INCLUDED	COMMENTS
	(FY77)		
1.	Tropical Prediction Spherical Harmonics	KEY	
2.	Primitive Equation Window Model for High Resolution, Short-Range Forecast	KEY	
3.	Total Electron Content Model	KEY	
4.	Ionospheric Ray Tracing Model	KEY	
5.	Conjugate Aurora Program		Not an Operational Model
6.	NOAA Ionospheric Scintillation Model		Model Inadequate
7.	Macroscale and High Resolution Cloud Prognoses	KEY	Dynamically Coupled to the Prediction Models
8.	Objective Horizontal Weather Depiction Model	LI	
9.	Terminal Forecast Model	X	
10.	Global Analysis	KEY	
	(FY78)		
11.	Advanced Satellite Data Incorporation into the Data Base and Analysis Cycles	X	
12.	Some High Resolution Data into Three-Dimensional Nephanalysis Programs	KEY	
13.	Advanced Global Atmospheric Prediction Model	KEY	
14.	Cloud Free Line of Sight Probability Matrices	KEY	
15.	Clear Line of Sight Probability Matrices	X	
16.	Statistical Polar Ionospheric Propagation Model	KEY	

TABLE 3 (Cont'd)

	MODEL	INCLUDED	COMMENTS
	(FY79)		
17.	Additional High Resolution Data Into Nephanalysis Programs		
18.	Extraction of Field of Motion from GOES Satellite Data	X	
19.	Satellite Data Compression Techniques		Not Required
20.	Statistical Interface Between Mesoscale Dynamic Model and Forecaster via MOS	LI	
	(FY80)		
21.	Ceiling, Visibility Forecast Probability of Success Indicators	LI	
22.	Incorporation of Satellite Derived Liquid Water Content	LI	
23.	Improved Total Electron Content Model	X	
24.	Improved F-Region Storm Model	X	
25.	Clear Line of Sight Probability Matrices for IR	X	
26.	Primitive Equation Window Model for High Resolution, Short-Range Forecasts at Low Altitudes	KEY	
37.	Radiation Physics Module into Global Prediction Model	X	In Advanced Prediction Model
	(FY81)		
27.	Variational Global Analysis Model	X	
28.	Satellite Sensor Simulation Model	LI	
29.	Ceiling, Visibility Forecast PSIs for Locations without Observations	LI	
30.	Clear Line of Sight Probability Matrices for Microwave Region	LI	
31.	Capability to Accept Data-Compacted Statistical Output from Digitized Radar		Accomplished Prior to GWC Receipt

TABLE 3 (Cont'd)

	MODEL	INCLUDED	COMMENTS
	(FY82)		
32.	Dynamically Coupled, Global, Cloud Forecast Model		In Advanced Prediction Model
33.	Liquid Water Prediction Capability		In Advanced Prediction Model
34.	Improved Ionospheric, Magnetospheric Model	X	
35.	Forecast PSIs for Severe Weather Related Phenomena	LI	
38.	Neutral Density Model	X	
	(FY83)		
36.	MOS Interface for Liquid Water Prediction Capability		Post 1982

2.1 MODEL DESCRIPTIONS

M1. Tropical Prediction Model Based on Spherical Harmonics (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Tropical forecasts satisfy user requirements R101, R126, R218, and R305, as well as those requirements of specific commands and agencies for more accurate wind and temperature forecasts. Present tropical forecasts are based on either persistence or climatology. Obviously these cannot be improved upon without the use of some dynamic model. A previous attempt at AFGWC to use quasi-barotropic theory for tropical prediction has not proved to be successful. There thus appears to be no alternative but to use a primitive equation formulation.

The spectral method has several potential advantages. There are no boundaries; the resolution can easily be changed by small increments; the use of semi-implicit methods of increasing the time step is particularly easy. If the model can produce more accurate forecasts than presently attainable, the above requirements will be satisfied, and the southern hemisphere forecast could be eliminated as a separate execute. This model would also serve as a test bed to examine the spectral approach as an ultimate replacement for finite-difference type models in the northern hemisphere.

2.0 DATA PROCESSING CHARACTERISITCS

Program Size: 75K
Wall Clock Time: 3600 seconds
CPU time: 2700 seconds
Temporary Mass Storage: 300,000 words
Requires optimized fast Fourier transform for efficient operation.
Program is intrinsically hemispheric or global.
Execution frequency: 2 runs/day

3.0 INPUTS

Requires output of global analysis program at 10 levels - heights, temperatures, winds (ultimately humidity). No boundaries (spherical coordinates).

4.0 OUTPUTS

Gridded global (lat-lon) fields of heights, temp, winds (ultimately humidity) at 10 levels, on which only data sources of $< 25^{0}$ N and S will be retained.

5.0 SCHEDULING CONSIDERATIONS

Requires prior execution of global analysis program. Precise scheduling not critical.

6.0 RUN-TIME SENSITIVITIES

This program will require buffered I/O to run at 75K.

It should be noted that CPU (Central Processing Unit) time and CAU (Command/ Arithmetic Unit) time are not the same. CAU measures accesses to memory rather than central processor utilization, and can differ greatly from what is often thought of as CPU. A program with no input/output can have a wall time much greater than CAU time, for example.

7.0 BIBLIOGRAPHIC REFERENCES

The model is based on that of Bourke - see Monthly Weather Review, October 1974.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

1.5 man-years of meteorologist-programmer personnel.

9.0 MISCELLANEOUS COMMENTS

A skeleton model has been written for the UNIVAC system. It is being converted to run on the UCLA 360/91 via the ARPANET.

M2. Primitive Equation Window Model for High Resolution, Short Range Forecast (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This model is related to user requirements R101, R120, and R404, plus possibly other classified requirements in the R100 ("Special Activities") category.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 260K
Wall Clock Time: 50 minutes
CPU Time: ≈ 50 minutes
Model is currently programmed for double CAU usage on the UNIVAC 1110.
Execution frequency: 8 times/day

3.0 INPUTS

Requires fine mesh analysis fields (presently generated for the U.S.)

4.0 OUTPUTS

Provides 49 X 49 grid of 1/8 mesh (26 nm between grid points), data for 10 levels every 2 to 18 hours; stored in data base. The forecasted meteorological parameters describe winds, temperature and moisture.

5.0 SCHEDULING CONSIDERATIONS

Present version would ideally run only when triggered by detection of areas in U.S. with high potential for severe weather. Future versions would run over fixed high-interest windows and in a relocatable mode for SX (now WPX) support.

6.0 RUN-TIME SENSITIVITIES

This model requires the use of an 1110 almost exclusively to run in times quoted in paragraph 2.0. Wall time will be greatly increased if the program is rolled out and in repeatedly.

7.0 BIBLIOGRAPHIC REFERENCES

Kaplan and Paine, "Journal of the Atmospheric Sciences", Volume 30, 1973, pp 213-222.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Not available.

9.0 MISCELLANEOUS COMMENTS

None.

M3. Total Electron Count (TEC) Model (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This model is required by Special Access programs involving ionospheris refraction/time delay. This is a high priority requirements, which is needed as soon as possible. The alternative is to continue with the inferior gridded TEC product. This new model will allow for mathematical smooth representation of the TEC field as opposed to a gridded field that requires interpolation (inaccurate recovery of data at other than grid points).

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 50 K (≈1,000 lines of FORTRAN code)
Wall Clock Time: 480 seconds
CPU Time: 420 seconds
Mass storage for data base: 35 tracks (62,720 words)
Execution Frequency: 4 times/day
Operator interface required: Yes

3.0 INPUTS

This model will employ the following:

Gridded fields from other major models
Manual bogusing
Raw data
Validated data
Data from specific geographic areas
First guess fields
Boundary values

4.0 OUTPUTS

This model will output the following:

Gridded fields (possibly)
Specific geographic areas
Disk storage
Run statistics
IPADS interface
Automatic initiation of successor models or packets

5.0 SCHEDULING CONSIDERATIONS

The product can be run once gridded fields are available from ITS (Institute for Telecommunication Sciences) raw data is available and checked, and bogused fields have been prepared. The only following operation is dissemination of the product to the customer.

6.0 RUN-TIME SENSITIVITIES

The area covered is a hemisphere with a mesh size of 300 nautical miles and a time step of 1 hour. The data base will be shared with other functions. Run time will be data dependent.

7.0 BIBLIOGRAPHIC REFERENCES

a. T.W. Flattery & A.C. Ramsay, "Derivation of Total Electron Content for Real Time Global Applications", presented at the 1975 NRL Symposium on the Effects of the Ionosphere on Space Systems and Communications.

b. T.W. Flattery: Informal Program Documentation.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Required resources include 1 meteorologist, 1 analyst, and 1 programmer expending 1/2 man-years of time in developing this model. 10 hours of computer time would also be used.

9.0 MISCELLANEOUS COMMENTS

None.

M4. Ionospheric Ray Tracing Model Which Considers Forward and Backscatter Effects (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This model is associated with requirements for R501, 503, 504, 505, 506, 509, 511, 512, 513, 514, and 518. Associated requirements are primarily those relating to high frequency radio propagation. The requirements for this model are high-priority, and it is needed as soon as possible. If this model is not implemented, inferior great circle ray propagation will have to be assumed. Since this model is meshed with real-time ionosphere, the E/M ray paths will be known much more accurately.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 75K (≈2,000 lines of FORTRAN code)
Wall Clock Time: 300 seconds
CPU Time: 240 seconds
Mass Storage: 30 tracks for data base (53,760 words)
Execution Frequency: 4 times/day or on demand
Operator interface is required.

3.0 INPUTS

Raw data will be used to update a gridded ionosphere model, which will be a primary input. Manual bogusing is a required capability. Boundary conditions may be a problem as the size of the area of interest decreases. Inputs will also include:

Gridded fields from other major models
Validated data
Data from specific geographic areas
First guess fields
Boundary values

4.0 OUTPUTS

Primary output consists of four-dimensional coordinates of ionospheric ray (approximately every 30 nm). Random access mass storage device will be required for data base output. IPADs may be useful for quality control and bogusing. Output will be sent to customer in a display or communication device. Outputs will also include run statistics and automatic initiation of successor models or packets.

5.0 SCHEDULING CONSIDERATIONS

Requirements are similar to the Total Electron Count Model (M3). Predecessor functions consist of gridded fields from ITS, raw data which has been checked, and prepared bogused fields. Successor functions consist of distribution to customers and storage on disk.

6.0 RUN-TIME SENSITIVITIES

Area of interest will vary in size, and primary output will trace position of atmospheric ray in space with time (position should be known about every 30 nautical miles).

7.0 BIBLIOGRAPHIC REFERENCES

AFCRL TR and informal program documentation.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Resources for development and implementation include 1 programmer, 1 analyst, and 1 metecrologist expending 1/2 man years. 10 hours of computer resources are necessary.

9.0 MISCELLANEOUS COMMENTS

None.

M5. CONJUGATE AURORA PROGRAM (1977)

This model is not an operational one, but rather a study program to determine if the southern hemisphere assumptions are correct. The results of the study have been implemented manually.

M6. NOAA Ionospheric Scintillation Model (1977)

The results of studying this model have proved inconclusive and therefore will not be considered for implementation in the new architecture.

M7. Cloud Prognoses Model - both Macroscale and High Resolution - Dynamically Coupled to the Prediction Models of Comparable Resolution (1977)

The timing, sizing, and run characteristics of this model will be the same as the Primitive Equation Window Model for High-Resolution Short-Range Forecast (M2). The model will be tailored to deal with those meteorological parameters involved with the prediction of clouds.

M8. Objective Horizontal Weather Depiction Model (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This project is a response to the requirement to conserve manpower in AFGWC/GF by replacing manual products with automated versions whenever possible. The OHM will reduce the workload for shift forecasters and should improve the accuracy and compatibility of forecast products (specifically U.S. forecasts (FAS) and TAFs). This model has a high in-house priority.

HWD charts are now produced manually. The approach to be used is to draw upon forecast parameters produced by the dynamic forecast models (Five layer cloud Model, Mesoscale Free Atmosphere Model, and the Boundary Layer Model) and to organize them into a specialized data base. At the same time, the OHM will produce forecasts of weather parameters not available in the dynamic models. This data base will be easily accessible as a single source for the creation of HWD forecast charts.

The overall result will be an automated comprehensive forecast utilizing more data in a given time frame than an individual forecaster could assimilate. This will, because of the objectivity, improve the compatibility and accuracy of forecast products and result in a reduction of manpower needs.

It is estimated that the resulting reduction of manpower needs will be on the order of 5 forecasters (DOO Letter, 11 December 1972).

Thus far, a partial data base has been established. At present, for five levels of the atmosphere (gradient, 850 MB, 700 MB, 500 MB, and 300 MB), cloud amounts, types, bases and tops AGL and icing types, intensity, bases and tops MSL are forecast. This is an intermediate step to aid the centralized terminal forecasters in their preparation of a first guess TAF. At this juncture, the first guess TAF is produced by accessing the pencil-follower input for low-level (less than 5,000 feet AGL) TAF elements and the OHM data base for high-level (equal to or greater than 5,000 feet AGL) TAF elements.

This project ties in with the Sensible Weather project, since the OHM generates and stores in its data base forecasts of weather parameters not available from other models. In addition, HWD display charts will be used with the Terminal Forecast Model (TFM) output for the FOUS and TAFs.

2.0 DATA PROCESSING CHARACTERISTICS

There are four possible OHM modules, any number of which could be in production. Three modules are 1/2 mesh windows (U.S., European, and Asian). Each of the three programs are approximately 51K in size, each requiring a storage array of 14,149 words for each time step, with time steps out to a maximum of 36 hours (dependent upon needs and availability of input models). Running time of each module involves 3 minutes CPU time and 15 minutes wall clock time. Each module is run at 03Z, 09Z, 15Z, and 21Z.

The whole mesh octagon requires coarse mesh input. It will run 4 times per day (00Z, 06Z, 12Z, 18Z) and stores a 23,975 word field for each time step (00, 06, 12, 18, 24, 36, 48). Program size will be 54K with run time involving 2 minutes CPU and 10 minutes wall clock time.

3.0 INPUTS

a. U.S. window:
- 1/2 mesh terrain
- 3DNEPH analysis
- 5-layer clouds
- 5-layer temperatures
- 5-layer icing
- mesoscale D-values
- BLM temperatures
- BLM moisture

b. European window:
- terrain
- 3DNEPH
- 5-layer clouds
- 5-layer temperatures
- 5-layer icing
- D-values
- BLM temperatures
- BLM icing

c. Asian window:
- terrain
- 3DNEPH
- 5-layer clouds
- 5-layer temperatures
- 5-layer icing
- D-values
- BLM temperatures
- BLM icing

d. Whole mesh octagon:
- terrain (1/2 mesh)
- MSC clouds
- MSC icing
- MSC temperatures
- 6-level D-values

4.0 OUTPUTS

See item 1.0 above.

5.0 SCHEDULING CONSIDERATIONS

See item 2.0 above.

6.0 RUN-TIME SENSITIVITIES

See item 2.0 above.

7.0 BIBLIOGRAPHIC REFERENCES

None.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

29 man months (11 used)
10 computer hours (4 used)

9.0 MISCELLANEOUS COMMENTS

No related efforts known. This project requires access to the AFGWC data base for completion and could therefore not be accomplished by another agency. If terminated, forecaster workload would not be reduced.

TAF preparation may not require the OHWD model. Also, Models M21, M29, and M35 may reduce the need for the OHWD. However, this is only true if all related model development efforts progress perfectly as scheduled. There still will be a need for the OHWD model over much of the 1977-82 time period.

If M21, M29, and M35 progress as planned, this OHWD may serve as a display tool to support these models, rather than as a self-sufficient model.

M9. Terminal Forecast Model (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This capability is related to requirements R404 and R602, and has a high in-house priority.

AFGWC has been directed by AWS to assume a large part of the terminal forecast function. This project is a response to the requirement for automated support to the Centralized Terminal Forecast Program (CTFP). If the goals of the program are to be accomplished with the limited available manpower, such automated support to AFGWC/GF is essential.

AFGWC produces terminal forecasts at the present time. However, their quality is limited by the inability of individual forecasters to mentally integrate in a limited time the vast amount of information which must be considered in making each forecast. Automated products which are not tailored for individual stations can only provide very general guidance and can do little to reduce the workload. Individual forecasters cannot adequately assimilate the local effects appropriate to 30 or more stations and combine them with current conditions and large scale changes into consistent and accurate terminal forecasts without automated help. Such forecasts include the prediction of "sensible weather", which is defined as encompassing cloud type, icing type and intensity, and precipitation type and intensity.

The TFM will create a first guess terminal forecast which the centralized terminal forecaster may review, and revise or accept. The TFM will do much of the "dog work" that the forecaster would normally be required to do. The TFM will access a number of analyses and prognoses, and surface observations for appropriate stations. The AFGWC models which will be accessed include the Boundary Layer Model, the Macroscale Free Atmosphere Model, the 3-D Nephanalysis and the Five Layer Cloud Model. Wind stratified conditional climatology (CC) for ceiling and visibility will be included within the TFM. Station local effects will be created for basic meteorological parameters by using statistics derived from comparisons of Boundary Layer Model Forecasts and corresponding surface observations. Most elements of a terminal forecast may be derived in a fairly straightforward fashion from the AFGWC models; however, low level cloudiness (below 5,000 feet AGL) and visibility must be created within the TFM through the use of other forecast parameters.

Thus far, a prototype version of the TFM has been created which accesses the AFGWC forecast fields and station conditional climatology. Local effects statistics are not yet available for inclusion in the TFM. A second version of the TFM has been programmed which may be more readily used in an operational environment. In addition to stations for which terminal forecasts will normally be routinely produced, non-routine (such as other terminals, targets, or drop zones) terminal forecasts may also be produced by the TFM, but such forecasts will not access conditional climatology and local effects statistics.

The accuracy of the TFM is partially dependent on improvement in other forecast models. The Sensible Weather and the Map Type Forecast System projects are required for the successful completion of the TFM project. The first stage of the Sensible Weather project has been to incorporate the forecasting of the required weather parameters into the AFGWC macro-scale and five-layer cloud models. This work is essentially completed. An initial verification program has been conducted which indicated specific forecast problems. The present product uses a number of empirical relationships which require improvement.

A statistical analysis of dynamic forecast parameters and station observations of the sensible weather parameters will be used to derive regression equations for forecast modification. A Model Output Statistic (MOS) approach using primarily cloud model output will be employed. Data is presently being collected and some initial correlations using one dependent and one independent variable have been established. The final MOS results will be applied to cloud model forecasts to give improved sensible weather forecasts to the Terminal Forecast Model and the objective Horizontal Weather Depiction Model.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 45K for largest absolute (≈4 absolutes in runstream)
Wall Clock Time: 3.5 minutes/run
CPU Time: 1.5 minutes
Run Frequency: Assuming 105 Conus stations with 1/4 of stations run every hour, with no run every 3rd hour or after 5th hour, indicates 8 runs per day with ≈25 stations/run.

3.0 INPUTS

a. Catalogued file: SWX CCDATA (12 positions)

b. Boundary layer model: [144]

hhUWU; hhUZ11; hhUD11
11 = 14, 58 [2] hh = 00, 01,... [3], [24], [20], (24 hours)

(Depends on start time of TFM for actual start of end times of the 24 hours of labels required.)

c. Half Mesh Clouds [8]

hhGC25 hh = 00, 03, 06,... 30 [8] (24 hours)

and icing [16]

hhGI11 11 = 87, 53 [2]
hh = 03, 06,..., 30 (24 hours) [8]

d. Whole Mesh Forecasts [16]

hhAZll; ll = 85, 70, 50, 30
hh = 06, 12,..., 36

e. Whole Mesh Analysis [4]

ØØAZll; ll = 85, 70, 50, 30

f. Eighth Mesh Cloud Analysis [5]

ØØSCbb; bb = 43, 44, 45, 52

g. Surface Obs [9]

Region nos: 25 to 28, 42 to 45, 53

TOTAL: Approximately 200 labels.

4.0 OUTPUTS

Forecasts are stored in the data base under the literal RTAFST, requiring 3 positions for the Automated TAF file.

5.0 SCHEDULING CONSIDERATIONS

See item 2.0 above.

6.0 RUN-TIME SENSITIVITIES

See item 1.0 above

7.0 BIBLIOGRAPHIC REFERENCES

None.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

a.	TFM:	50 man months (31 used) 36 computer hours (14 used)
b.	Sensible Weather:	28 man months (23 used) 20 computer hours (10.5 used)

9.0 MISCELLANEOUS COMMENTS

The Technique Development Laboratory of the National Weather Service has been working on computerized terminal ceiling, visibility, temperature and surface wind forecasts, principally through the model output statistics approach. The Fleet Numerical Weather Central has also done some work on terminal forecasting

through analog methods. The AF Cambridge Research Laboratory has been involved with short range terminal forecasting through use of a high density, meso-net grid of meteorological instruments.

It might be difficult for an agency external to the AFGWC to fully develop this technique because the required programs are closely linked to the AFGWC operating system and data base. However, while the final software interface must be developed at AFGWC, the technique could conceivably be developed anywhere.

If current trends in manpower reduction and forecast centralization are extended, the AFGWC will be tasked to do more with less people. The computer concept of support to the centralized terminal forecaster is absolutely necessary under these trends. Failure to continue and implement the Terminal Forecast Model project will necessitate requesting additional manpower to perform the centralized terminal forecast function, or result in a degradation of forecast quality.

National Weather Service/TDL is using MOS to aid in forecasting ceiling, precipitation probabilities, surface winds, surface temperatures, and surface visibility. Their forecasts use the output of the Subsynoptic Advection Model (SAM), the Primitive Equation (PE) model, and selected surface observations as the input into their techniques.

M10. Global Analysis (1977)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

The present analysis program (MULTAN), together with the tropical analysis program, provides for the whole globe. These are pieced together, and the programs do not enforce consistency between the parameters analyzed. For more sophisticated models which permit gravitational modes to exist, the initial mass and velocity fields must be related in a realistic way. A more sophisticated analysis program is thus a prerequisite for advanced global models.

2.0 DATA PROCESSING CHARACTERISTICS

Program size: 65K, including I/O buffer size (all FORTRAN)
Wall Clock Time: 2400 seconds
CPU Time: 2000 seconds
Temporary Mass Storage: 400,000 words
Execution Frequency: 4 times/day
Requires all available observations. This is a highly vectorized operation. Form is intrinsically hemispheric or global.

3.0 INPUTS

All observations (validated data). First guess forecast from global data base.

4.0 OUTPUTS

Gridded global fields (lat-lon).
Spectral coefficients ($\approx$16000).

5.0 SCHEDULING CONSIDERATIONS

This model takes approximately the same time as all of the present analysis programs, but cannot be split up efficiently - that is, to run only the northern hemisphere would take approximately as long as to do the whole globe. Therefore to replace MULTAN with the global analysis would delay the present schedule.

6.0 RUN-TIME SENSITIVITIES

Model is dependent on buffered input/output. Run time is data-dependent.

7.0 BIBLIOGRAPHIC REFERENCES

a. Flattery, "Spectral Models for Global Analysis and Forecasting", AWS Tech Report 242, April 1971, pp. 42.

b. National Weather Service, Tech Procedures Bulletin #105, January 10, 1974.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Program is complete. 3 Meteorologist-Programmer man months required to interface model with system.

9.0 MISCELLANEOUS COMMENTS

None.

M11. Advanced Meteorological Satellite Data Incorporation into the Data Base and into the Analysis Cycles (1978)

This is a rather broad topic, but will most likely include the following:

First a relocatable window of WHR and VHR satellite data stored in a satellite global data base format (no data compaction involved). This topic will be discussed as M11.1 below.

Second, addition of data from secondary and new sensors to a data base. This topic will be discussed under M11.2 below.

M11.1: Relocatable Window for Satellite Data

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

The first general topic, a relocatable window with no data compaction, would be the first step in making WHR and VHR data available for cloud analysis and clear displays. This higher resolution data offers some definite advantages over its coarser counterpart in cloud analysis. These will be brought out more clearly under the discussion of model M12 following. First data can presently be displayed very clearly in its analog form, but by mapping it into the SGDB, it can be gridded and successive passes can be merged together to form a large uniform picture. The mapping can furthermore be done in any fashion the user requires (e.g., polar stereographic or mercator). Because data compaction is not seen as a possibility at this time (and because this data may not be available over the entire globe) first data base will most likely be limited to areas of primary interest (e.g., Special Projects requirements).

These data are approximately eight times finer on a side (1/3 - 1/2 nm) than the high resolution data (2 - 3 nm) but in other respects can be handled the same by AP. The resources to develop this capability then involve modification of existing programs to handle the denser data.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 80K
Wall Clock Time: 10 minutes
CPU Time: 5 minutes
Execution Frequency: The program will be executed each time a satellite pass of interest is available.

3.0 INPUTS

The input to the programs involved would be the digital satellite data as it comes from the DF; it would then be mapped into the specific grid desired and stored on disk (80 positions). The capability to routinely quality control this data, such as via IPADS, must be allowed for.

4.0 OUTPUT

The data must be introduced to SGDB as soon as it is available (which means immediately after it is read out from the satellite). These readout times are irregular but are known well in advance, so they can be scheduled easily. These readouts also trigger other data flow (such as the high resolution data and that from secondary sensors) so they are being entered into the system at a time of peak demand.

5.0 SCHEDULING CONSIDERATIONS

See item 4.0 above.

6.0 RUN-TIME SENSITIVITIES

See item 4.0 above.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

This development could be completed by one programmer/analyst during a 6 month period. This should involve about 50 hours of computer time.

9.0 MISCELLANEOUS COMMENTS

None

M11.2 Addition of Data From Secondary and New Sensors

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Data from secondary sensors other than the now commonplace H and IR offers many possibilities for satellite derived meteorology. Two such packages include microwave data and the H package. Since microwave data is less sensitive to water vapor than its IR counterpart, it offers possibilities for improvement to the areas of temperature determination both vertically (microwave sounder) and at the surface (microwave imager) for all types of weather conditions. (The present VTPR package is useless over cloudy areas.) Microwave imager data has also proved useful in studying areas covered by ice and snow. There is a developing interest in a snow cover analysis (recently implemented at GWC), so that data might also prove quite useful in this area.

2.0 DATA PROCESSING CHARACTERISTICS

Microwave Imager Data

Program Size: 45K (3,000 lines of Fortran code)
Wall Clock Time: 3 minutes
CPU Time: Less than 1 minute
Temporary Mass Storage: 128 tracks

H Package (a combination of VTPR, humidity, and ozone sensors)

Program size: 45K (about 6,000 lines of Fortran code)
Wall Clock Time: 8 minutes
CPU Time: 2 minutes
Temporary Mass Storage: 128 tracks

3.0 INPUTS

We will utilize readouts of data from satellites as soon as these data are available.

4.0 OUTPUTS

Output fields will be either gridded (where a microwave imager is involved) or a number of individual soundings (for the VTPR data).

5.0 SCHEDULING CONSIDERATIONS

The microwave programs will be executed every time a readout is available with the appropriate satellite data. 12 executions per satellite per day is a maximum estimate.

6.0 RUN-TIME SENSITIVITIES

See item 5.0 above.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Software to handle microwave data is being developed by an outside contractor, so resources to be expended by AFGWC are not a factor. The development of models for other types of secondary data is being done by AFGWC personnel, and should involve 3 meteorologists and 1 programmer/analyst over a period of 1 year. This would also involve about 50 hours of computer time.

9.0 MISCELLANEOUS COMMENTS

None

M12. Incorporation of Some Very High Resolution, Visible and Infrared Satellite Data Into Three Dimensional Nephanalysis Programs (1978)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This is a capability which was demonstrated at GWC more than a year ago, but the methods used showed little improvement in products. Some amount of development is therefore necessary to successfully complete the project with improved results. In other words new and different methods will have to be developed.

Besides making a better cloud amount determination, it is thought that this higher resolution data would significantly help in identifying cloud types (this goal is of interest to WPJ). Furthermore, the denser IR data should help to more carefully locate more cloud layers than is possible now.

The very high resolution data will most likely be available (for partial hemisphere or relocatable window) in a SGDB for an area roughly equivalent to the Eurasian land mass. (The SGDB assumption remains consistent with the interpretation outlined under Model 11.) Thus, about 3% of available fine data is expected to be processed in 1978.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 70K (approximately 1,500 lines of FORTRAN code)
Wall Clock Time: 10 minutes
CPU Time: 5 minutes

3.0 INPUTS

This SGDB data base would probably require about 260 positions of disk mass storage, with an additional 450 positions for raw data. This would be the actual data (not compacted).

The input data is approximately 1/3 nm (1/64 mesh) on each side.

4.0 OUTPUTS

The output fields, or cloud analysis, would be 1/8 mesh or 26 nm on each side. This output data would then be integrated with other 3DNEPH inputs to produce a final cloud analysis which is then used to initiate cloud forecast models, etc.

5.0 SCHEDULING CONSIDERATIONS

The program would probably execute about 4 times per day, when new data is available.

6.0 RUN-TIME SENSITIVITIES

The program would most likely be I/O bound, having to do about 750 retrieves per data type (H&I) of 5K buffers.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

This model should require 1 meteorologist working 1 year with the assistance of 1 programmer/analyst over 1/2 years time. Computer resources include 50 hours of batch time and 10 hours of block time.

9.0 MISCELLANEOUS COMMENTS

None

M13. Advanced Global Atmospheric Prediction Model (1978)

1.0 RELATIONSHIP OF OPERATIONAL REQUIREMENTS

Experience has shown that the development of the numerical models is a lengthy and difficult process. Even when specific techniques are well known and verified their use and combination can often lead to unanticipated problems. It is therefore necessary, if AFGWC is to have a global prediction model incorporating all physical processes which can be successfully modeled, to begin work on it now. This is true even though the hardware upgrade necessary to run it may be several years away. Priority of this model will be high (in-house), if a computer upgrade occurs. There is no present capability.

Present computer limitations at AFGWC preclude all but the most basic design factors from being developed. In order to proceed beyond this stage, computer time must become available on a machine faster than those at GWC. Approval of the DAR requesting access to the ARPA net would permit some development activity to proceed. More sophisticated design features could be tested, and programming of most modeled features could be completed. However, the final testing of the model and verification of product quality requires a machine comparable to that upon which the final model would be run. The project must then remain essentially at a standstill until adequate resources become available.

The APM is a response to virtually every requirement which requires improvement in the forecast accuracy of basic meteorological parameters. Our present models have reached the limit of their predictive capability. No amount of tinkering with their numerics is going to significantly improve their performance.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 140K
Wall Clock Time (1108): 10 hours
CPU Time (1108): 8 hours
Temporary Mass Storage: 800,000 words
Execution Frequency: 2 times per day

This model appears to be ideal for parallel processing.

3.0 INPUTS

This model requires gridded global analysis at 2° lat-lon intervals at 12 pressure levels.

4.0 OUTPUTS

This model will output forecasts in the same form as inputs at 2 or 3 hour intervals to 36 hours, and at 6 hour intervals to 72 hours.

5.0 SCHEDULING CONSIDERATIONS

This program must run to 72 hours in 2 hours of wall time. It must be finished 4-1/2 hours after synoptic times.

6.0 RUN-TIME SENSITIVITIES

See item 5.0 above.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

This model will require at least 3 man months per month, and 5 hours of computer time per month on the ARPA net.

9.0 MISCELLANEOUS COMMENTS

Advanced models are being used at several locations. These include the Geophysical Fluid Dynamics Laboratory of NOAA and the National Center of Atmospheric Research. Global models are also used or planned at the Goddard Institute for Space Studies, the National Meteorological Center, the Fleet Numerical Weather Facility, and at UCLA. None of these models is suited for use at AFGWC. Those designed for the general circulation contain features unnecessary for day to day forecasting and none have placed stress on cloud forecasting, which is an area vital for GWC operational requirements. Model development of this type could in principal be accomplished by AFCRL. However, to be given a program of the complexity of an APM with no experience in its construction or characteristics could create severe maintenance difficulties.

See additional comments under Model M37.

M14. Cloud Free Line of Sight Probability Matrices (1978)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This is a key model requirement that will be employed to support several key users who have requirements for CFLOS, such as R105, R106, R108, R109, R208, R216, and others.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 260K
Wall Clock Time (1108): 32 hours per update
CPU Time: 14 hours per update
Mass Storage Requirements: 6×10^6 words
Update Frequency: 2 per day

3.0 INPUTS

Input information includes the potential line of sight path or family of paths to be computed. Also will be the input probability data probably from the meteorological data base and/or resulting from forecast.

4.0 OUTPUTS

The output will be a probability associated with each path (or as a function of members of the family).

5.0 SCHEDULING CONSIDERATIONS

This program will be run twice per day.

6.0 RUN-TIME SENSITIVITIES

Must follow the primary meteorological prediction model and finish within 9 hours of the analysis time.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

This capability requires 2 man months of meteorologist support and 1 man year to program. Computer resource includes 25 hours of batch time with 5 hours of block time.

9.0 MISCELLANEOUS COMMENTS

None

M15. Clear Line of Sight Probability Matrices (1978)

The CFLOS/CLOS model must be a dynamic model giving the CLOS probability and duration for two vehicles at different locations moving at different velocities. This is considered to be a simple add-on to the Cloud Free line of sight capability representing an amount of effort over and above M14 considered to be insignificant to the architectural study.

M16. Statistical Polar Ionospheric Propagation Model (1978)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Programs establishing requirements are documented in R503, R506, R511, R512, R513, and R514. All programs establishing requirements are ionospheric dependent or are involved with AF communications and surveillance systems. This model has a high priority requirement and is needed by 1978 at the latest. The alternative to implementing this model is to continue using the ITS. It is anticipated that this model will provide better propagation specification and forecasts for polar regions.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 50K (approximately 4,000 lines of FORTRAN code)
Wall Time: 480 seconds
CPU Time: 360 seconds
Mass Storage (for data base): 30 tracks
Execution Frequency: 6 times per day

It is doubtful that parallelism would be useful. Operator interface is required. The model will probably consist of two program modules: 1) building of the ionosphere; 2) a propagation model.

3.0 INPUTS

Raw data (observations) will be used to update a gridded ionosphere model which will be a primary input. Manual bogusing is a required capability. The model will be limited to specific geographic areas.

4.0 OUTPUTS

Output data will trace the position of a ray in space (about every 30 nm) with time. Random access mass storage device will be required for the output data base. IPADS may be useful for quality control and bogusing. Final output will be sent to customers via display or communications devices.

5.0 SCHEDULING CONSIDERATIONS

Execution of this program is tied to both predecessor and successor functions.

6.0 RUN-TIME SENSITIVITIES

Mesh steps are 200 nm, and time steps are 1 hour for ionospheric specifications. Geographic areas will be window or hemispheric for ionosphere point-to-point propagation. The data base will be shared with other functions. The more data present, the slower the model will run.

7.0 BIBLIOGRAPHIC REFERENCES

a. Bradley, P.A. and Murphy, J.A., "A Method of Prediction of Median HF Oblique Sky-Wave Propagation Loads in Field Strengths", SRC Appleton Laboratory, Slough, United Kingdom.

b. AFCRL TR-783-0331, Elkins, T. J. (Editor) "An Empirical Model of the Polar Ionosphere".

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Development resources involve 1 meteorologist, 1 analyst, and 1 programmer using 1 man year of time. 25 hours of batch computer time and 3 hours of block time is also needed.

9.0 MISCELLANEOUS COMMENTS

None

M17. Incorporation of Additional Very High Resolution Visible and Infrared Satellite Data into Nephanalysis Programs (1979)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This capability (probably not actually implemented until 1980) would involve the incorporation of up to 10% of available fine data into the 3-D nephanalysis program.

2.0 DATA PROCESSING CHARACTERISITCS

Program Size: 60K (approximately 2,000 FORTRAN statements)
Wall Clock Time: 5 to 15 minutes
CPU Time: 3 to 10 minutes (depending on how large a geographic area has to be covered)
Execution frequency: up to 20 times per day

3.0 INPUTS

Raw digitized satellite data (1350 positions)

4.0 OUTPUTS

It is estimated that such a polar stereographic data base covering the globe would require approximately 780 positions.

5.0 SCHEDULING CONSIDERATIONS

See item 2.0 above.

6.0 RUN-TIME SENSITIVITIES

The program would have to do a significant amount of I/O. Buffers would now be reduced to about 1K in size, but as many as 3,500 per data type (H&I) must be initiated if a program is running over an entire hemisphere.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

The real cost of this project would be in the development necessary to implement it, if compaction techniques were to be implemented (no one is continuing in Captain Sikula's place at present). Much research is necessary to be done in this area of analyzing Fourier components for cloud information. It is estimated that this would take 1 meteorologist over a 3 year period. He would need the assistance of 1 programmer/analyst for the final year. The cost of the system would be about 250 hours in batch time runs and 50 hours in block time, with most of it in the final year.

9.0 MISCELLANEOUS COMMENTS

This development would probably have applications in areas other than 3DNEPH. It might prove useful to any program routinely accessing a compacted SGDB (a snow depth analysis program for example). AWS has submitted a technical need requesting AFCRL to pursue this work.

M18. Programs to Extract Field of Motion from GOES Satellite Data (1979)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This analysis technique would supplement conventional wind observations.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 366K bytes
Wall Clock Time: 28 minutes } in IBM 360/195 units
CPU Time: 5-7 minutes
Mass Storage: 610 IBM tracks per "picture". 2 "pictures" (satellite readouts) are required to perform the wind analysis, and a third picture is kept on tape for backup.

3.0 INPUTS

The last two GOES satellite readouts (and probably a conventional wind analysis for quality control and added accuracy).

4.0 OUTPUTS

Wind analysis (speed and direction at several heights) over selected areas of satellite coverage at a mesh size of 25nm (1/8 mesh) or larger.

5.0 SCHEDULING CONSIDERATIONS

It would probably be desirable for AFGWC to perform the analysis 4 times per day (every 6 hours) but since the only data used now is video, night time operations would have to be suspended. AFGWC would then most likely perform the analysis 3 times per day.

Program statistics listed above must be multiplied by the number of satellites being used operationally (the figures above were estimates obtained from NESS). NESS only attempts to determine low level winds, so if AFGWC is to also perform a high level wind analysis, the program size and run time would probably increase.

6.0 RUN-TIME SENSITIVITIES

See item 5.0 above.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

If GWC is to perform the development necessary to implement this model, they would most likely start with the NESS code, and make the necessary conversions to run it on UNIVAC hardware. This task would take approximately 4 man years.

9.0 MISCELLANEOUS COMMENTS

None

M19. Satellite Data Compression Techniques (1979)

Compression techniques for raw satellite data will not be considered in the architecture study. Indications are that large volume mass storage devices can easily accomodate the quantities of data expected from 1977-82 at reasonable cost. While some reductions in computer time may occur by working with compressed data, it is doubtful that the large programming efforts required to develop the compression and extraction algorithms would justify relatively small reductions in program operating times.

M20. Statistical Interface Between Mesocale Dynamic Model and Forecaster via MOS (1979)

This requirement will not be considered in the architecture study. The load on the computer is assumed to be insignificant. The regression analysis takes about 5 seconds.

M21. Ceiling Visibility Forecast Probability of Success Indicator (PSIs) for Locations with Observations (1980)

This requirement will not be considered in the architectural study since computation is minimal. Therefore there is no impact on the data system.

M22. Incorporation of Satellite-Derived Liquid Water Content into the Data Base (1980)

This requirement will not be considered in the architecture study, since computer impact is minimal. This requirement will probably be accomplished via a table lookup.

M23. Improved Total Electron Content (TEC) Model (1980)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This capability is required by several special access programs. The programs requiring this model involve ionospheric range/refraction correction. Priority behind this model is medium. The best TEC model is needed as more data become available and new techniques are developed. These will be incorporated into environmental model for TEC. If this model is not implemented no improvements will be made to the existing system and progress will be ignored. This model will allow for use of the latest technology and technical developments.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 100K (approximately 2,000 lines of FORTRAN code)
Wall Clock Time: 600 seconds
CPU Time: 480 seconds
Mass Storage: 100 tracks for data base
Execution Frequency: 4 times per day. Operator interface is required.

3.0 INPUTS

Input and output fields are essentially the same as described in M3, Total Electron Content (TEC) model. The difference is that this new model will now make use of more advanced technology available.

4.0 OUTPUTS

See item 3.0 above.

5.0 SCHEDULING CONSIDERATIONS

There are both predecessor and successor functions that could be scheduling conflicts and other impacts on the existing schedule.

6.0 RUN-TIME SENSITIVITIES

The mesh size is coarse (25 nm) and time steps will be 30 minutes. Geographic area covered will be a hemisphere.

7.0 BIBLIOGRAPHIC REFERENCES

Information is evolving in technical memoranda, journals, and studies.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Development resources include 2 meteorologists, 1 analyst, and 1 programmer, expending 4 man years of effort. Computer resources include 200 hours of batch time and 10 hours of block time.

9.0 MISCELLANEOUS COMMENTS

None

M24. Improved F-Region Storm Model (1980)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Programs establishing requirements are documented under user requirements R504, R505, R506, R511, R512, R513, R514, and R518. These programs primarily involve HF propagation.

The storm effects on the F-region are not handled well now. Basic improvements are needed. Failure to implement this model will result in no improvements over the low capability of today. This is a medium priority task which is needed by 1981 at the latest. This model will provide for better HF propagation and HF surveillance specification and forecasting.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 50K (about 1,000 lines of FORTRAN code)
Wall Clock Time: 300 seconds
CPU Time: 240 seconds
Mass Storage: 200 tracks needed for the data base
Execution Frequency: 4 times per day or in demand mode. Operator interface is necessary.

3.0 INPUTS

Raw data observations will be used to update a gridded field which will serve as a first guess. Manual bogusing is a required capability. The model will be limited to specific geographic areas of interest (possibly on a hemispheric basis).

4.0 OUTPUTS

Output data will trace the position of a ray in space with time. Random access mass storage devices will be required for the data base. IPADS may be useful for quality control and bogusing. Output will be sent to customers via display or communication devices.

5.0 SCHEDULING CONSIDERATIONS

Scheduling involves both predecessor and successor functions. There may be scheduling conflicts.

6.0 RUN-TIME SENSITIVITIES

Grid size is 100 nm and time steps will be 30 minutes. The geographic area will vary from window to hemisphere. The data base will be shared with other functions.

7.0 BIBLIOGRAPHIC REFERENCES

Information is evolving in technical memoranda, studies, and journals.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Development resources will involve 1 meteorologist, 1 analyst, and 1 programmer expending 2 man years of effort. Computer resources include 100 hours batch time and 5 hours of block time.

9.0 MISCELLANEOUS COMMENTS

None

M25. Clear Line of Sight Probability Matrices for IR (1980)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Unknown.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 260K
Wall Clock Time (1108): 59 hours per update
CPU Time (1108): 25 hours per update
Mass Storage: 32 positions
Update Frequency: 2 updates per day

These estimates are based on 22 3DNEPH boxes, each of which contains 64 X 64 1/8 mesh points.

3.0 INPUTS

Assumed to be the same as M14.

4.0 OUTPUTS

See 3.0 above.

5.0 SCHEDULING CONSIDERATIONS

See item 2.0 above.

6.0 RUN-TIME SENSITIVITIES

Must follow the primary meteorological prediction model and finish within 9 hours of the analysis time.

7.0 BIBLIOGRAPHIC REFERENCES

None

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Not available

9.0 MISCELLANEOUS COMMENTS

None

M26. Primitive Equation Window Model for High Resolution Short Range Forecast at Low Latitudes (1980)

The timing, sizing, and run characteristics of this model will be same as the primitive equation window model (M2) for high resolution short-range forecasts.

[1] M37. Radiation Physics Module Global Prediction Model (1980)

A basic radiation physics module is planned for the Advanced Prediction Model in 1978. This will be upgraded by 1980, adding 20% to the APM's running time.

[1] NOTE: M37 was initially assumed to be a 1982 requirement, and originally followed M36. It has now been listed as a 1980 capability, retaining the same model designator of M37.

M27. Variational Global Analysis (1981)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This is a more sophisticated analysis technique which permits the specification of relationships between the variables analyzed. The same comments which apply to Global Analysis (M10) are appropriate for this project.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 140K
CPU Time: 3,600 seconds

3.0 INPUTS

See M10

4.0 OUTPUTS

See M10

5.0 SCHEDULING CONSIDERATIONS

See M10

6.0 RUN-TIME SENSITIVITIES

See M10

7.0 BIBLIOGRAPHIC REFERENCES

a. Lewis, "An Operational Upper Air Analysis Using the Variational Method," Tellers, 1972, p 514

b. Sasaki, 1958, Journal of the Met Society of Japan, pp. 77-88

c. Sasaki, 1969, Journal of the Met Society of Japan, pp. 115-124

d. Sasaki, 1970, Monthly Weather Review, pp. 875-910

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

1 meteorologist man year and 2 analyst/programmer man years.

9.0 MISCELLANEOUS COMMENTS

None.

M28. Satellite Sensors Simulation Model (1981)

This a a study activity and has no impact on the sizing of the operational system except for a relatively small amount of computer usage during the software development and accomplishment of the study.

M29. Ceiling Visibility Forecast PSIs for Locations Without Observations (1981)

This model will not be considered in the study. Computation is minimal with no impact.

M30. Clear Line of Sight Probability Matrices for Microwave Region (1981)

This model will not be considered in the study. Computation is minimal with no impact.

M31. Capability to Accept Data Compacted Statistical Output from Digitized Radar (1981)

Under the current design concept, the data compacting task will be accomplished by a mini-computer at individual or regional radar sites, and will not be accomplished at AFGWC. Therefore, this requirement will not be considered in the architecture study.

M32. Dynamically Coupled Global Cloud Forecast Model (1982)

The advanced prediction model (M13) will include this capability.

M33. Liquid Water Prediction Capability (1982)

The advanced prediction model (M13) will include this capability.

M34. Improved Ionospheric Magnetospheric Model (1982)

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

Requirements for this model are established by all user agencies in the R500 series (Space Systems and Environment Support). Programs affecting this model include all ionospheric/plasma/neutral density affected or dependent systems. This is a medium priority task. There is a need for a quantitive model for ionospheric magnetosphere for objective assessment of the environment. If this model is not implemented, qualitative data processing techniques will be continued. This model will provide quantitive objective assessments of the environment.

2.0 DATA PROCESSING CHARACTERISTICS

Program Size: 125K (3,000 lines of FORTRAN code)
Wall Clock Time: 600 seconds
CPU Time: 480 seconds
Mass Storage Requirements: 200 tracks needed for the data base
Execution Frequency: 12 times per day or on demand

Operator interface will be required.

3.0 INPUTS

This model will require the following:

a. Gridded fields from other major models
b. Manual bogusing
c. Raw data
d. Validated data
e. Data from specific geographic areas
f. First guess fields
g. Boundary values

4.0 OUTPUTS

This model will produce the following:

a. Gridded fields
b. Specific geographic areas
c. Data storage on disk
d. Run statistics
e. IPADS output
f. Automatic initiation of successor models or packets

5.0 SCHEDULING CONSIDERATIONS

Predecessor and successor functions are both involved with this program. There may be scheduling conflicts.

6.0 RUN-TIME SENSITIVITIES

The mesh size is 50 nm and the time step is 10 minutes. The geographic area will vary from window size to an entire hemisphere. This program will be sharing the data base with other functions.

7.0 BIBLIOGRAPHIC REFERENCES

Information is evolving in technical memoranda, studies, and journals.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Resources to be expended prior to implementation include 2 meteorologists, 1 analyst and 1 programmer for 5 man years of effort. 500 hours of batch computer time and 20 hours of block time are also needed.

9.0 MISCELLANEOUS COMMENTS

None.

M35. Forecast PSIs for Severe Weather Related Pheonomena (1982)

This model will not be considered in the architecture study. Computation is expected to be minimal with no significant impact.

M36. MOS Interface for Liquid Water Prediction Capability (1983)

This is a post-1982 requirement, and will not be considered in this architecture study.

M38. Neutral Density Model

1.0 RELATIONSHIP TO OPERATIONAL REQUIREMENTS

This model would generate atmospheric density information, using F10.7 solar flux parameters and A_p planetary magnetic index parameters. This information would be forwarded to the NORAD Space Defense Center and other agencies requiring such information to refine space vehicle ephemerides. Currently, AWS only provides F10.7 and A_p parameters to these users, who must then compute their own density values.

2.0 DATA PROCESSING CHARACTERISITCS

Assumed program size: 100K words
Assumed execution time: 15 minutes of 1108 time per run
Assumed run frequency: one/day
Assumed storage requirement: 200K words

3.0 INPUTS

F10.7 and A_p parameters.

4.0 OUTPUTS

Atmospheric density data for the desired period.

5.0 SCHEDULING CONSIDERATIONS

Not generally time critical - should be run at non-peak periods.

6.0 RUN-TIME SENSITIVITIES

Run time would probably vary as a function of the length of time (no. of revs, days, etc.) for which atmospheric density information is desired.

7.0 BIBLIOGRAPHIC REFERENCES

None.

8.0 RESOURCES REQUIRED FOR IMPLEMENTATION

Not available.

9.0 MISCELLANEOUS COMMENTS

Work in this area is being done by Dr. Ken Champion and Mr. Paul Fougert at AFCRL.

2.2 MODEL REQUIREMENT/FUNCTION RELATIONSHIPS

REQUIREMENTS

MODELS	SPECIAL ACTIVITIES 1 0 1 2 0123456789012345678901234567890123456789	COMMAND CONTROL 2 0 2 1 0123456789012345678	EWO 3 0 012345	ENVIRON. SUPPORT 4 0 4 1 01234567890123456	SESS 5 0 5 1 0123456789012345678	GEN. 6 0 012
1	X XX X	XXX XXXXXXXXXX XXX	XXXXX	X X	X X	
2	X XX X XXXXXXX X X X	XXX XXXXXXXXXX XXX	XXXXX	X		
3	X				X X	
4					X XXXX X XXXX X	
5	STUOY PROGRAM ONLY - NOT AN OPERATIONAL MODEL					
6	NOT CONSIDEREO FOR IMPLEMENTATION - MODEL STUOY RESULTS INCONCLUSIVE					
7	X X X XXXXXXX XX X					
8	XX X	XXX X XXXXXXX XXX	XXXXX	X		X
9	XX X	XXX X XXXXXXX XXX	XXXXX	X X		X
10	X X X X	XXX X XXXXXXX XXX	XXXXX			
11	X XX XXX XXXXXXXXXXX X			X	X	
12	X XX XXX XXXXXXXXXXX X		X			
13	X XX X	XXX X XXXXXXX XXX	XXXXX		X X	
14	XX XX	X X	X			
15	XX XX	X X	X			
16					X X XXXX	
17	X XX XXX XXXXXXXXXXX X		X			
18	X X	XX XXX XX XXXX	XXXXX	X	XX X	
19	NOT CONSIDEREO FOR IMPLEMENTATION - CONSIOEREO TO BE UNNECESSARY					
20	NOT CONSIOEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAD					
21	NOT CONSIOEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAD					
22	NOT CONSIOEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAD					
23	X				X X	
24					XXX XXXX X	
25	XX XX	X X	X			
26	X X X XXXXXXX XX X					
27	X X X X	XXX X XXXXXXX XXX	XXXXX			
28	STUDY PROGRAM ONLY - NOT AN OPERATIONAL MODEL					
29	NOT CONSIOEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAO					
30	NOT CONSIOEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAO					
31	NOT CONSIDEREO FOR IMPLEMENTATION - DATA COMPACTING ASSUMEO TO BE PERFORMED BEFORE RECEIPT AT GWC					
32	X XX X	XXX X XXXXXXX XXX	XXXXX		X X	
33	X XX X	XXX X XXXXXXX XXX	XXXXX		X X	
34					XXXXXXXXXXXXXXXXXX	
35	NOT CONSIDEREO FOR IMPLEMENTATION - INSIGNIFICANT LOAO					
36	NOT CONSIDERED FOR IMPLEMENTATION - POST 1982 REQUIREMENT					
37	X				X X	
38	XXX XX				X	

Figure 6. AFGWC Requirements/Models Correlation.

2.3 ANALYSIS OF THE BENCHMARK SPECTRAL ALGORITHM

This report consists of an analysis of the weather prediction equations provided to SDC by Lt. Colonel T. Flattery of AFGWC. The analysis is directed at choosing an appropriate flow for the solution of the equations, and then counting operations and determining storage requirements. The solution of the equations provides a prognosis of the atmospheric state which depends upon initial conditions and the atmospheric model. The operations count provides an estimate of run time based upon some assumptions about the computer and availability of hardwired algorithms such as the Fast Fourier Transform.

The equations are very simplified fluid flow equations with a solution based upon the technique of spectral analysis. For these benchmark equations, a solution at one atmospheric level provides full knowledge of the atmosphere at all heights. However, to extrapolate for more complex and realistic models, the timing is based upon a 12-level solution. A variety of techniques exist that may be used to solve the benchmark equations, even within the realm of spectral analysis. The technique described here, called the "full transform" method, has been chosen because it allows for evaluation of the state (weather) at each time step without extra computation.

2.3.1 Benchmark Equations

The equations provided by AFGWC are to be considered as a benchmark for the sizing and timing analysis of the spectral technique in weather prediction. The form of the equations results from a series of assumptions; that the atmosphere is dry, adiabatic, and barotropic. The last term is equivalent to the assumption that pressure is only a function of density, allowing the solution to be limited to a single layer (Haltiner, p. 116). The resulting equations involve the horizontal wind velocities and the height of the isobar surface $p = p_0$. This approximation yields solutions that carry the large-scale weather phenomena but cannot generate new systems. Moreover, the calculations are characteristic of accurate, complete models with fewer simplistic approximations.

However, it should be noted that some of the calculations involved in more complicated models are not easily related to the algorithm described below. These calculations are generally in the context of a process that is expressed in integral rather than differential form. The two most important processes of this type result from radiation and precipitation. Both of these calculations are very difficult and should be performed external to the spectral analysis. For this reason, even though the processes are vital to weather prediction, they will be omitted from this discussion.

The equations of interest, basically in the form provided, are given below.

$$\frac{\partial u}{\partial t} + \frac{u}{a\cos\phi}\frac{\partial u}{\partial \lambda} + \frac{v}{a}\frac{\partial u}{\partial \phi} - \frac{uv\tan\phi}{a} - fv + \frac{\partial gh}{a\cos\phi\partial\lambda} = 0$$

$$\frac{\partial v}{\partial t} + \frac{u}{a\cos\phi}\frac{\partial v}{\partial \lambda} + \frac{v}{a}\frac{\partial v}{\partial \phi} + fu + \frac{u^2\tan\phi}{a} + \frac{\partial gh}{a\partial\phi} = 0 \qquad (1)$$

$$\frac{\partial h}{\partial t} + \frac{u}{a\cos\phi}\frac{\partial h}{\partial \lambda} + \frac{v}{a}\frac{\partial h}{\partial \phi} + h\left(\frac{\partial u}{a\cos\phi\partial\lambda} + \frac{1}{a}\frac{\partial v}{\partial\phi} - \frac{v\tan\phi}{a}\right) = 0$$

where:

λ = longitude
ϕ = geocentric latitude
f = $2\Omega\sin\phi$
g = geopotential
a = mean radius of earth
Ω = angular rotation of the earth 7.29×10^{-5} rad/sec
u,v = horizontal velocity components
h = height of isobaric surface

The integration is to be performed on a sphere with boundary condition of regularity at the poles (automatically satisfied by (2) below). Assume a representation for the dependent variables of the form

$$u\cos\phi = \sum_{n,\ell} [a_n^\ell(t)\cos\ell\lambda + b_n^\ell(t)\sin\ell\lambda]\, P_n^\ell(\sin\phi) ,$$

$$v\cos\phi = \sum_{n,\ell} [c_n^\ell(t)\sin\ell\lambda - d_n^\ell(t)\cos\ell\lambda]\, P_n^\ell(\sin\phi) , \qquad (2)$$

$$gh = \sum_{n,\ell} [e_n^\ell(t)\cos\ell\lambda + f_n^\ell(t)\sin\ell\lambda]\, P_n^\ell(\sin\phi) ,$$

where the a_n^ℓ, b_n^ℓ, c_n^ℓ, d_n^ℓ, e_n^ℓ, f_n^ℓ are the unknown expansion coefficients, and the $P_n^\ell(\sin\phi)$ are associated Legendre polynomials. The notation $\sum_{n,\ell}$ will be explained below.

If we substitute (2) into (1) after multiplying the first two equations by $\cos\phi$, we obtain

$$\sum_{n,\ell} \left[\frac{da_n^\ell}{dt}\cos\ell\lambda + \frac{db_n^\ell}{dt}\sin\ell\lambda\right] P_n^\ell(\sin\phi) = K_u ,$$

$$\sum_{n,\ell} \left[\frac{dc_n^\ell}{dt}\sin\ell\lambda - \frac{dd_n^\ell}{dt}\cos\ell\lambda\right] P_n^\ell(\sin\phi) = K_v , \qquad (3)$$

$$\sum_{n,\ell} \left[\frac{de_n^\ell}{dt}\cos\ell\lambda + \frac{df_n^\ell}{dt}\sin\ell\lambda\right] P_n^\ell(\sin\phi) = K_h .$$

The expressions that K_u, K_v, K_h represent are

$$K_u = -\cos\phi \left[\frac{u}{a\cos\phi}\frac{\partial u}{\partial\lambda} + \frac{v}{a}\frac{\partial u}{\partial\phi} - \frac{uv\tan\phi}{a} - fv + \frac{\partial gh}{a\cos\phi\partial\lambda}\right] ,$$

$$K_v = -\cos\phi \left[\frac{u}{a\cos\phi}\frac{\partial v}{\partial\lambda} + \frac{v}{a}\frac{\partial v}{\partial\phi} + \frac{u^2\tan\phi}{a} + fu + \frac{\partial gh}{a\partial\phi}\right] , \qquad (4)$$

$$K_h = -\left[\frac{u}{a\cos\phi}\frac{\partial h}{\partial\phi} + \frac{v}{a}\frac{\partial h}{\partial\phi} + h\left(\frac{u}{a\cos\phi\partial\lambda} + \frac{1}{a}\frac{\partial v}{\partial\phi} - \frac{v\tan\phi}{a}\right)\right] .$$

The K_u, K_v, and K_h are then each amenable to a spectral representation of the form

$$K = \sum_{n,\ell} \left[Q_n^\ell \cos\ell\lambda + R_n^\ell \sin\ell\lambda\right] P_n^\ell(\cos\phi).$$

The notation $\sum_{m,n}$ in these equations represents an expansion with a double summation of the form

$$\sum_{m,n} = \sum_{n=0}^{\infty}\sum_{m=0}^{n} .$$

For practical use, this infinite double sum is truncated in both indices. The truncation has traditionally taken two forms:

a) triangular truncation (TT)

$$\sum_{m,n} = \sum_{n=0}^{N^*-1}\sum_{m=0}^{n} , \text{ and}$$

b) rhomboidal truncation (RT)

$$\sum_{m,n} = \sum_{m=0}^{M-1}\sum_{n=m}^{m+N-1} .$$

For the case $M = N^*$, the two techniques are represented by the same number of longitudinal functions. However, it appears that the rhomboidal type may have more resolution in latitude. It is not clear whether the additional resolution

is worth the extra work required. For generality, both techniques will be considered; the appropriate notation, TT or RT, will be used to indicate which one is meant.

To propagate the state of the system from a known state, initial conditions may be critical to the success of a technique. For this study, however, we shall take the initial conditions as given. By this we mean that a matrix of values is available that contains all required functions at each position and index. In general, this implies the a priori knowledge of

$$u(\lambda_i, \phi_j, t_0) ,$$

$$v(\lambda_i, \phi_j, t_0) ,$$

$$h(\lambda_i, \phi_j, t_0) ,$$

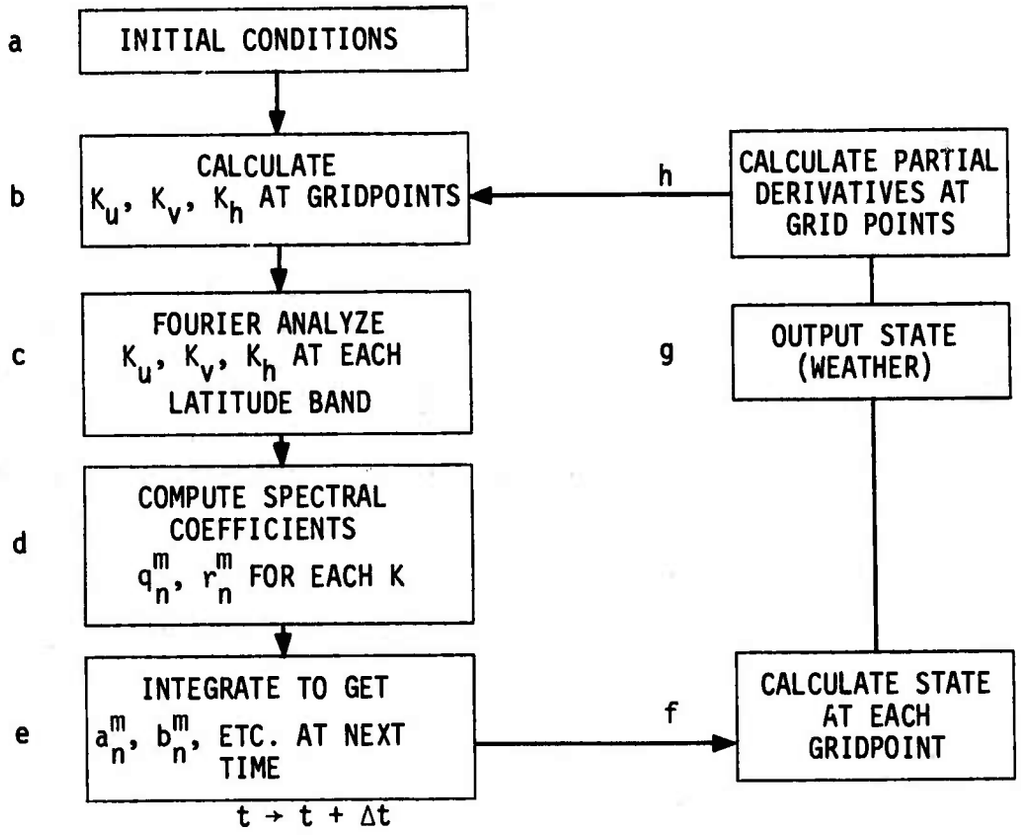
$\frac{\partial u}{\partial x}(\lambda_i, \phi_j, t_0)$ and all other required partial derivatives, and

the spectral coefficients of equation 3: a_n^m, b_n^m, c_n^m, etc.,

where the λ_i, ϕ_j are the positional grid points, and (n,m) are the index values of the TT or RT truncation. Note that knowledge of the primitive quantities u, v, h is equivalent to knowledge of a_n^m, b_n^m, etc. We are assuming, however, that they are both given simultaneously.

2.3.2 Propagation of the AFGWC Equations

The simplest way to represent the solution of the system in section 2.3.1 is by reference to the flow diagram shown below. Each block of the flow diagram is explained in the body of this section. As will be seen, the techniques of spectral analysis are required in blocks c and f. Where techniques are common, reference is made to the appendix of this section, which explains the method in general terms.



a. Initial Conditions

As explained in section 2.3.1, initial conditions are assumed to be available as needed.

b. Evaluation of the Function K_u, K_v, K_h

The three functions K_u, K_v, and K_h depend upon the values of the position, velocities, and isobar height. They must be evaluated at each grid point for the full transform method (see introduction). The points shall be identified as

$$(\lambda_i, \phi_j) \qquad \begin{matrix} i = 0, \cdots, I \\ j = 0, \cdots, J. \end{matrix}$$

The values of I and J will be identified in section 2.3.3. For the present, it is sufficient to state that they relate to the resolution and to the truncation type (TT/RT).

Given the values of the dependent and independent variables (from block f), evaluation of the K function is a straightforward mix of multiplies, divides, and sums according to the formulae of equation 4.

c. Fourier Analyze K_u, K_v, K_h at each latitude $\phi = \phi_j$

For each $K(=K_u, K_v, K_h)$, and each latitude ϕ_j, $j=0,\cdots,J$, a Fourier coefficient vector $C(\phi_j)$ is formed, where

$$C(\phi_j) = [C_m(\phi_j),\ m=0,\cdots,M-1], \text{ and}$$

$$C_m(\phi_j) = \frac{1}{M} \sum_{\ell=0}^{I-1} K(\lambda_\ell, \phi_j) \exp(im\lambda_\ell), \tag{5}$$

where the function K assumes the value of each of (K_u, K_v, K_h) evaluated at the proper grid point.

NOTE: This Fourier transform may be computed using an FFT. See the appendix of this section for an explanation.

d. Compute Spectral Coefficients for the K_u, K_v, and K_h

The spectral analysis of the K functions is completed when the coefficients Q_n^m and R_n^m for each K are computed via quadratures of the type

$$Q_n^m = \sum_{j=0}^{J-1} C_m(\phi_j)\ \omega(\phi_j)\ P_n^m(\phi_j)\ , \tag{6}$$

and for the indices

$$\begin{aligned} &n = 0,\cdots,N^*-1 \\ &m \leq n \end{aligned} \qquad \text{TT}$$

or

$$\begin{aligned} &n = 0,\cdots,M-1 \\ &n \leq m + N - 1, \end{aligned} \qquad \text{RT}$$

where $\omega(\phi_j)$ are the quadrature weight functions for a Gaussian quadrature with J points. For each $K = K_u$, K_v, K_h, we have a complete set of coefficients of this type.

e. Time Integration of the Spectral Coefficients

According to equation 3, the spectral coefficients of the (K_u, K_v, K_h) are simply the time rates of the coefficients for the velocity components and isobar height. We may now integrate these rates to predict the dependent variables at the next time.

Thus,

$$\begin{aligned} t_{i+1} &= t_i + \Delta t, \\ a_n^m(t_{i+1}) &= a_n^m(t_{i-1}) + 2\Delta t\ Q_n^m(t)\ , \\ b_n^m(t_{i+1}) &= b_n^m(t_{i-1}) + 2\Delta t\ R_n^m(t)\ , \\ &\vdots \end{aligned} \tag{7}$$

for all indices of the TT/RT truncation.

f. Calculate the State

This block comprises the actual prognostic for which the system is designed. As mentioned in the introduction, the full transform technique allows for intermediate prognostics without extra calculation.

We now have the spectral coefficients for the dependent parameters and must invert the harmonic transform. This is accomplished in two steps:

1) calculation of intermediate Fourier coefficient, and
2) inverse Fourier transform at each latitude.

The intermediate Fourier coefficients are formed at each latitude ϕ_j, j=0,···,J-1:

$$u_m(\phi_j) = \sum_n a_n^m P_n^m(\mu_j) ,$$

$$v_m(\phi_j) = \sum_n c_n^m P_n^m(\mu_j) , \text{ and} \qquad (8)$$

$$h_m(\phi_j) = \sum_n e_n^m P_n^m(\mu_j) ,$$

where

$$\mu_j = \sin\phi_j ,$$

a_n^n, c_n^m, e_n^m are complex coefficients (see this section's appendix), and

$$\sum_n = \begin{cases} \sum_{n=0}^{N^*-1} & (TT) \\ \sum_{n=m}^{m+N-1} & (RT) \end{cases}$$

The state itself is then calculated through the Fourier inversions

$$u(\lambda_K,\phi_j)\cos\phi_j = \sum_m u_m(\phi_j)\exp(im\lambda_K),$$

$$v(\lambda_K,\phi_j)\cos\phi_j = \sum_m v_m(\phi_j)\exp(im\lambda_K), \qquad (9)$$

$$gh = \sum_m h_m(\phi_j)\exp(im\lambda_K).$$

Note that this step may be accomplished with a Fast Fourier Transform (FFT). This is explained in the appendix of this section.

g. Output Weather State

At this point, the weather parameters are available for display. If the final time has been reached, the prediction stops here.

h. Calculate Other Required Quantities

The functions K_u, K_v, K_h depend upon λ, ϕ, u, v, h, and other quantities not directly available. These include the partial derivatives of the state, such as

$$\frac{\partial u}{\partial x}, \frac{\partial u}{\partial y},$$

$$\frac{\partial v}{\partial x}, \frac{\partial v}{\partial y}, \text{ and}$$

$$\frac{\partial gh}{\partial x}, \frac{\partial gh}{\partial y}.$$

However, these partials may be computed from spectral forms based on equation 2. Some manipulation and use of recursion relations is required.

Each of the primitive variables ($u\cos\phi$, $v\cos\phi$, gh) is expandable in the form

$$f(\lambda, \phi) = \sum_{m,n} F_n^m \exp(im\lambda) P_n^m(\mu) . \tag{10}$$

The partials are then given by

$$\frac{\partial f}{\partial \lambda} = \sum_{m,n} im F_m^n \exp(im\lambda) P_n^m(\mu) ,$$

$$\frac{\partial f}{\partial \phi} = \sum_{m,n} F_n^m \exp(im\lambda) \frac{dP_n^m}{d\mu}(\mu)(1-\mu^2)^{1/2} . \tag{11}$$

For each of these expressions, new spectral coefficients may be found so that $\frac{\partial f}{\partial \lambda}$ and $\frac{\partial f}{\partial \phi}$ are expressible in forms similar to $f(\lambda, \phi)$. For instance, if

$$D_n^m = im F_n^m , \text{ then}$$

$$\frac{\partial f}{\partial \lambda} = \sum_{m,n} D_n^m \exp(im\lambda) P_n^m(\mu) . \tag{12}$$

This is an expansion in surface spherical harmonics. Thus, the same algorithms may be used to compute the required quantities for $\partial f/\partial\lambda$ as were used for $f(\lambda, \phi)$. The case of $\partial f/\partial\phi$ is somewhat different because $\frac{dP_n^m}{d\mu}$ is not a simple combination of other P_n^m functions. In fact,

$$(\mu^2-1)\frac{dP_n^m}{d\mu}(\mu) = (n-m+1) P_{n+1}^m(\mu) - (n+1)\mu P_n^m(\mu) . \tag{13}$$

However, in this case, it does not hurt to leave the expansion in the form

$$\frac{\partial f}{\partial \phi} = \sum_{m,n} F_n^m \exp(im\lambda) R_n^m(\mu) , \tag{14}$$

where

$$R_n^m(\mu) = [(n-m+1)P_{n+1}^m(\mu) - (n+1)\mu P_n^m(\mu)]/(1-\mu^2)^{1/2} .$$

$R_n^m(\mu)$ is a function which may be as easily computed as $P_n^m(\mu)$.

To solve for the values of $\partial f/\partial\phi$, $\partial f/\partial\lambda$ at the same grid points used for (u, v, gh), we first form the intermediate Fourier series at each latitude ϕ_j, j=0,···,J:

$$\frac{\partial f}{\partial \lambda}(\lambda, \phi_j) = \sum_m f_\lambda^m(\phi_j) \exp(im\lambda) \tag{15}$$

where

$$f_\lambda^m(\phi_j) = \sum_n im F_n^m P_n^m(\mu_j), \text{ and}$$

$$\frac{\partial f}{\partial \phi}(\lambda, \phi_j) = \sum_m f_\phi^m(\phi_j) \exp(im\lambda)$$

$$f_\phi^m(\phi_j) = \sum_n F_n^m R_n^m(\mu_j)$$

We may now solve for the $\frac{\partial f}{\partial \lambda}(\lambda_i, \phi_j)$ and $\frac{\partial f}{\partial \lambda}(\lambda_i, \phi_j)$ using the same techniques used in calculating the u, v, and gh at the same grid points.

2.3.3 Truncation, Resolution, and Grid Points

Up to this point, both truncation limits and grid points have been left undetermined. We shall attempt to leave the choice between triangular truncation and rhomboidal truncation free, but relate the grid-point scheme to the truncation limits. In some sense, resolution is proportional to truncation limits, but it is not clearly established whether TT is better or worse than RT, considering computation versus results. Likewise it is not clear how many terms of TT or RT are required to yield meaningful results on a given physical scale. Thus the truncation limits will be left as a variable.

The barotropic equations of section 2.3.1 are highly nonlinear. This means that when analyzed in spectral form, the solution spreads in time through wave number (or phase) space unless controlled by some assumption. In real life, of course, energy is lost from the fluid in very high wave-number phenomena, known as eddies. These wave numbers are generally out of the range of any reasonable truncation. Therefore, a careful integration substitutes this energy in another form (such as heat), and cuts off the spectral form at a finite, a priori limit. The benchmark equations are simplified, having no heat input at all. However, the truncation is carried out anyway. The truncation limits are fixed and the same for all quantities, linear or nonlinear.

However, the existence of the product terms should not be ignored. In fact, these terms determine the grid-point scheme since the number of grid points determines the accuracy of the spectral decomposition.

As an heuristic demonstration of the problem of spreading in wave number, consider two functions, f(x) and g(x), such as

$$f(x) = e^{ix} + e^{2ix} \quad \text{and}$$
$$g(x) = e^{ix} - e^{2ix} . \tag{16}$$

The Fourier transforms of these are obviously

$$F_1 = 1, F_2 = 1 \text{ and}$$

$$G_1 = 1, G_2 = -1 \ .$$

These transforms could have been formally calculated by Brigham (p. 98)

$$F_j = \frac{1}{3} \sum_{k=0}^{2} f(x_k)\, e^{-i2\pi jk/3} \ , \text{ and}$$

$$G_j = \frac{1}{3} \sum_{k=0}^{2} g(x_k)\, e^{-i2\pi jk/3} \ , \tag{17}$$

where

$$j=0,\cdots,N-1 = 2 \ .$$

Notice the summation $k=0,\cdots,N-1 = 2$.

The nonlinear terms look like products $f(x)g(x)$. The Fourier transform of $h(x) = f(x)g(x)$ is given by

$$H_k = \frac{1}{M} \sum_{m=0}^{N-1} f(x_m)g(x_m)e^{-2\pi imk/N},$$

$$k=0,\cdots,2N-2 = 4 \ , \text{ and} \tag{18}$$

$$h(x) = f(x)g(x) = e^{2ix} - e^{4ix} \ .$$

This multiplication and spreading effect in transform, or phase space, occurs in the nonlinear terms K_u, K_v, and K_h. In our treatment the spreading will be disallowed. That is, for a function such as $h(x)$, the transform vector would only be calculated for $k=0,\cdots,N-1 = 2$. However, to calculate accurately those allowed values of H_k, the number of grid points would be allowed to be $2N-2 = 4$.

In the same sense, for the benchmark equations, the grid-point scheme is chosen to accurately calculate those terms of the transformed nonlinear products within the truncation limits of the linear physical quantities.

Thus, to choose the grid-point scheme, we must know

1) the form of (K_u, K_v, K_h), and

2) the rules for exact spectral analysis of a function whose components themselves are finite spectral polynomials.

Investigation of K_u, K_v, and K_h indicates a sum of products of terms such as products of velocities and partial derivatives of velocities. The velocities may be considered to have polynomials in λ of degree up to $2R_1$, where $R_1 = N^*-1$ (TT) or M + N-1 (RT). The partials, however, may have polynomials of degree up to $2R_2$, where $R_2 = N^*$ (TT) or (M+N) (RT) (see equation 11, section II). Thus, products that occur in (K_u, K_v, K_h) must be considered to have degree 2M and order $(R_1 + R_2)$.

The rules for exact Fourier transforms of a 2M order harmonic series require 2M equally spaced grid points in a 2π interval. Thus the longitudinal grid points are spaced at intervals of $2\pi/2M$. However, bear in mind that only the first M harmonics are solved.

The latitude bands are chosen by considering the quadrature specified in equation 6. The $C_m(\phi)$ are polynomials of degree $\leq 2(R_1+R_2)$, and are multiplied by $P_n^m(\phi)$, which are polynomials of degree $\leq 2R_1$. Thus a Gaussian quadrature of order $2R_1 + R_2$ will exactly capture the coefficients.

Note $2R_1 + R_2 = \begin{cases} 3N^* & TT \\ 3(M+N) & RT \end{cases}$

The grid points are chosen to be

$\{\lambda_i\}$ $i=0,\cdots,I = 2M-1$,

where $\Delta\lambda = \pi/M$; and

$\{\mu_j\}$ $j=0,\cdots,J = 2R_1 + R_2 - 1$

where $P^0_{2R_1+R_2}(\mu_j) = 0$.

2.3.4 Analysis of Computation Required

Once the latitude-longitude grid has been fixed relative to a spectral truncation, it is possible to analyze the operations required to cycle through the algorithm of section 2.3.2. This section will be devoted to a count of operations, leading to an estimate of run time for the solution of the benchmark equations. The counting will follow the outline of section 2.3.2.e and the flowchart. Timing will be based upon several assumptions:

1) A unit computational step takes time δt = 100 nanosec.

2) A unit computational step consists of

   a) one multiply add, or
   b) one multiply, or
   c) one divide.

3) Fourier transforms and inverses may be accomplished by use of a prepackaged FFT (see the appendix).

4) Timing of FFT is proportional to $N\log_2 N$, where N = number of grid points.

The counting and timing process will follow section 2.3.2 and the flowchart in outline.

a. Initial Conditions

Assume no computation required.

b. Evaluation of K_u, K_v, K_h

Assume all required quantities are available; that is, we have

$$\begin{pmatrix} u, & v, & h \\ \frac{\partial u}{\partial x}, & \frac{\partial v}{\partial x}, & \frac{\partial h}{\partial x} \\ \frac{\partial u}{\partial y}, & \frac{\partial v}{\partial y}, & \frac{\partial h}{\partial y} \end{pmatrix}_{\lambda_i, \phi_j}$$

$$\begin{pmatrix} \cos\phi \\ \tan\phi \\ \{P_n^m(\phi)\} \\ \{R_n^m(\phi)\} \end{pmatrix}_{\phi = \phi_j, \text{ all required indices}}$$

for $i = 0,\cdots,I-1$, and $j = 0,\cdots,J-1$

From the form of the (K_u, K_v, K_h) we can see each one requires a combination of roughly 10 multiply-adds, multiplies, or divides. Thus the sum total of unit computation times is

$$T_B = 3 \times I \times J \times 10\,\delta t = 30\,IJ\delta t.$$

c. Fourier Analyze K_u, K_v, K_h at Each Latitude

For a presentation of FFT notation, please see the appendix.

We now have Fourier transforms to compute for each K, at each of the J latitudes, with each Fourier transform using I data points. This computation is represented by

$3J \times$ FFT (I),

with computation time of

$$T_C = 3J \cdot T_F(I)$$

Note that although I data points are used, only M harmonics of each transform are saved. This allows some saving in computation time.

d. Compute Spectral Coefficients for K_u, K_v, K_h

The completion of the spectral analysis of the K_u, K_v, K_h requires quadratures that take the form of sums of products over all permissible indices for each Fourier coefficient of equation 5, and for each K. Each summation has J terms

of the form

$$C_m(\phi_j)\ \ w(\phi_j)\ P_n^m\ (\phi_j).$$

We assume that the functions $w(\phi_j)\ P_n^m(\phi_j)$ are precalculated and stored.

The number of such sums depends upon the truncation type. For TT, we have N*(N*-1)/2 spectral coefficients. For RT, we have NM terms. Thus the time required for this calculation is given by

$$T_D = 3PJ\delta t,$$

$$\text{where} \qquad P = \begin{cases} N^*(N^*-1)/2 & (TT) \\ NM & (RT) \end{cases}$$

e. Time Integration

Each of the 3P coefficients of equation 6 represents time rates that must be integrated to evaluate the physical quantities at the next time. Since each integration is represented by a single multiply-add, the computation time for this step is given by

$$T_E = 3P\delta t.$$

f. Calculate the State (u, v, h)

The intermediate Fourier series coefficients at each latitude are each computed from series of R* multiply-adds, where

$$R^* = \begin{cases} N^* & (TT) \\ N & (RT). \end{cases}$$

The number of coefficients, times the number of terms per coefficient for each physical quantity, is represented by R, where

$$R = \sum_{m=0}^{M} R^* = P = \begin{cases} N^*(N^*-1)/2 & (TT) \\ MN & (RT). \end{cases}$$

Thus the time for the intermediate Fourier series at all latitudes, for all physical quantities, is

$$T_{F_1} = 3JR\delta t = 3JP\delta t.$$

The state itself is then calculated by inverting the Fourier series at each latitude, for each physical quantity. This is represented by the operations

$$3J \cdot FFT(I) \quad \text{(see the appendix to this section)}$$

and the time

$$T_{F_2} = 3J \cdot T_F(I)$$

g. Output Weather

Computation and Timing for this section is unknown.

h. Calculate Partial Derivatives

The auxiliary required quantities that must be evaluated are the partial derivatives

$$\frac{\partial u}{\partial x}, \frac{\partial v}{\partial x}, \frac{\partial h}{\partial x} \text{ and}$$

$$\frac{\partial u}{\partial y} \quad \frac{\partial v}{\partial y} \quad \frac{\partial h}{\partial y} .$$

These are given by formulae identical in computational form to the physical quantities themselves. Thus the time taken to compute them is

$$T_H = T_{H_1} + T_{H_2} = 6\ J\ R\delta t + 6\ J\ T_F(I).$$

SUMMARY

The total run time per time step is given by

$$T = \Sigma T_i$$

$$= 3\{J[(I+3R+P)\delta t + 4T_F(I)] + P\delta t\}.$$

For the TT/RT truncations, this becomes

$$T(TT) \cong 3\{(3N^*-1)[(2N^*-1+4N^*(N^*-1)/2)\delta t + 4T_F(2N^*-1)] + N^*(N^*-1)/2\delta t\}$$

$$\cong 18[N^{*3}\delta t + 2N^*\ T_F(2N^*-1)], \text{ and}$$

$$T(RT) \cong 3\{(3(M+N)-1)[2M-1+4MN)\delta t + 4T_F(2M-1)] + N(M+N)\delta t\}.$$

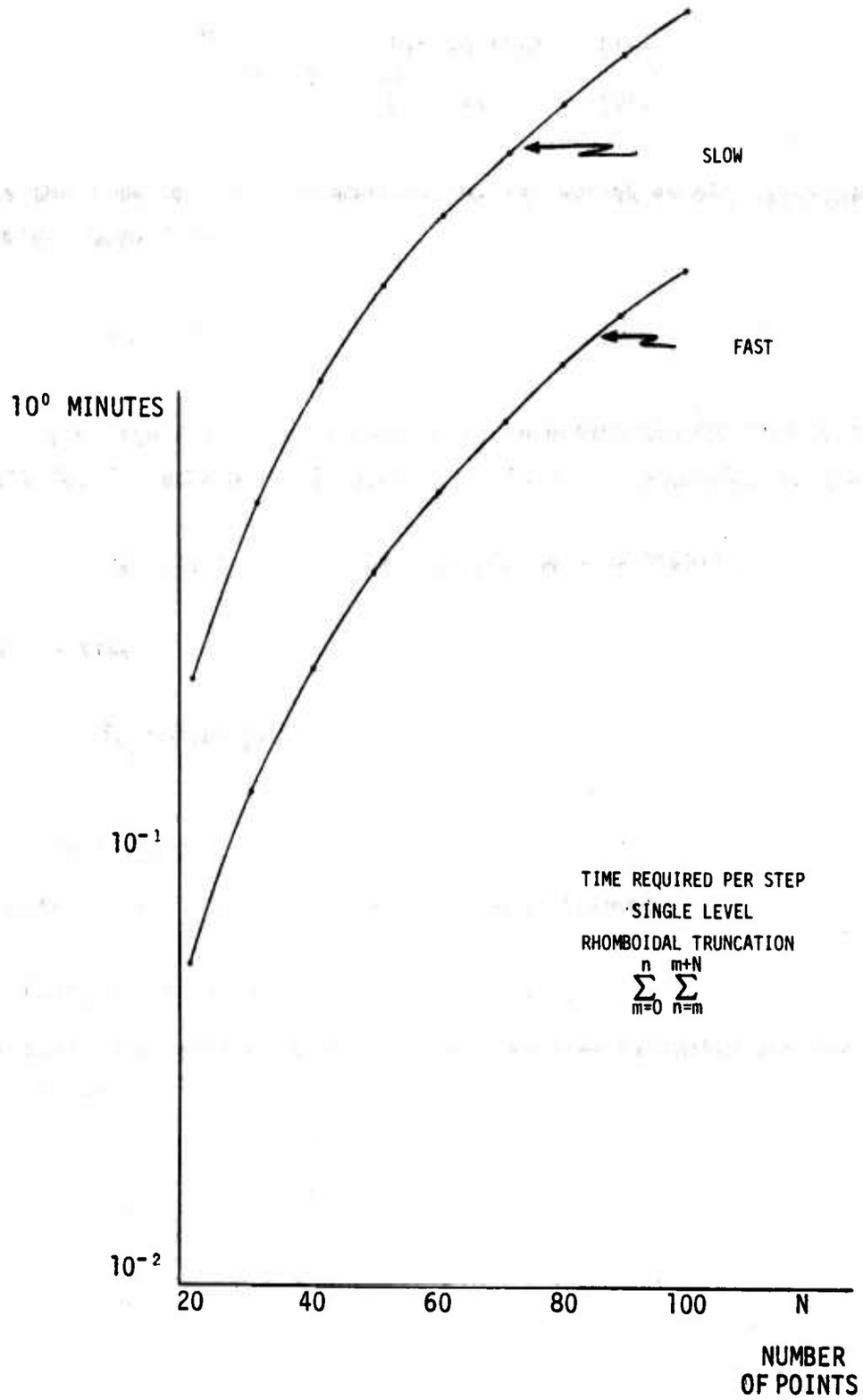
Assuming M and N to be of similar magnitude, we get

$$T(RT) \cong 9(M+N)[4MN\delta t + 4T_F(2M-1)]\ .$$

Note that if M = N, as is generally the case, we have

$$T(RT) \cong 18N[2N^2\delta t + 4T_F(2N-1)]\ .$$

Thus, as can be seen, the rhomboidal truncation requires twice as many operations as the triangular when M=N=N*. The results of this analysis for RT are indicated in the following figure for a range of M (=N). The time scale indicates the time for a single step in the single-layered model.


SLOW
FAST
10^0 MINUTES
10^{-1}
10^{-2}
TIME REQUIRED PER STEP
SINGLE LEVEL
RHOMBOIDAL TRUNCATION
$\sum_{m=0}^{n} \sum_{n=m}^{m+N}$
20
40
60
80
100
N
NUMBER
OF POINTS

We then make the following set of crude approximations:

1) An L-layered atmospheric model requires L times as much computation as a single-layered model.

2) We use a .5 hour time step.

3) The output is a 72-hour prognostic.

The resulting times, being the first set multiplied by a factor of 144LT(RT) is shown in the next figure for the case L = 12.

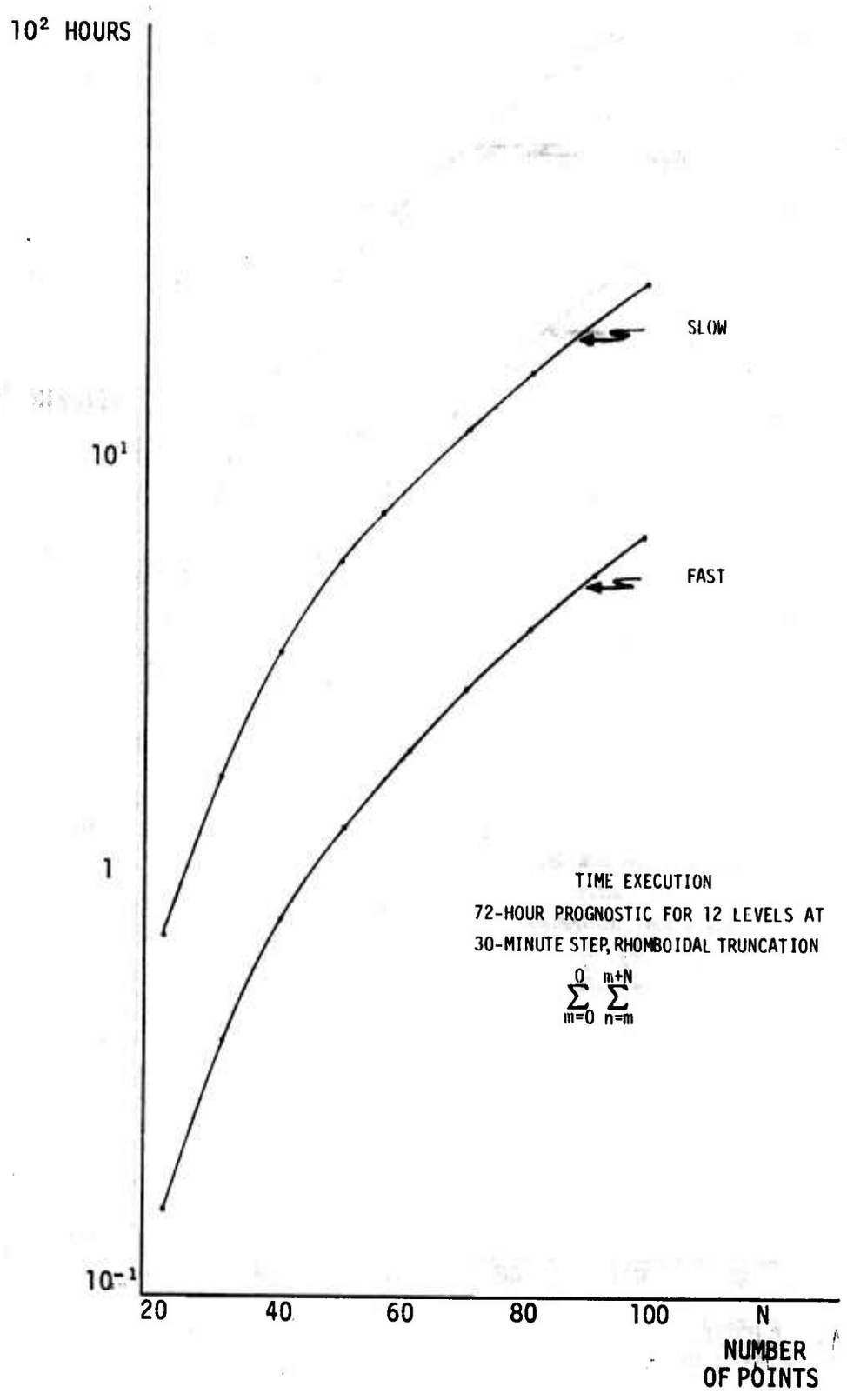
For each figure, the assumption has been made that

$$T_F\ (2N\text{-}1) \sim \frac{N\log_2 N}{10^3}\ T_F\ (1024),$$

where

$$T_F\ (1024) = \begin{cases} 10 \text{ msec} & \text{slow: standard FFT package} \\ 2 \text{ msec} & \text{fast: fastest FFT available} \end{cases}, \text{ and}$$

$$\delta t = 100 \text{ nanosec} = 10^{-7} \text{ sec.}$$


10^2 HOURS
10^1
1
10^{-1}
SLOW
FAST
TIME EXECUTION
72-HOUR PROGNOSTIC FOR 12 LEVELS AT
30-MINUTE STEP, RHOMBOIDAL TRUNCATION
$\sum_{m=0}^{0} \sum_{n=m}^{m+N}$
20
40
60
80
100
N
NUMBER
OF POINTS

2.3.5 Storage Requirements

Certain quantities that occur in the algorithm require storage. Some of these items are precalculated and used many times. Others are recalculated at each step. This distinction may enable a separation of storage into permanent and temporary locations. However, for this section, that distinction will be ignored. The count will include all items which are either required as constants or as the result of an operation. In particular, only the final result of a summation will be counted for storage.

Since it is important to know the length of particular vectors or matrices, each item is shown separately in the following list. As a tool for later reference, the length or dimension of each item will be specified. Also, the page where the item has been defined will be listed in the last column.

Items that have a dimension of 1 (scalars) will not be listed since they are negligible compared to the large arrays.

DIMENSIONS

Item	Name	Dimension	Definition Page
K_u	interaction term	IJ	6
K_v	interaction term	IJ	6
K_h	interaction term	IJ	6
u	velocity	IJ	6
v	velocity	IJ	6
h	isobar height	IJ	6
$\sin\phi=\mu$	trigonometric function	J	6
$\cos\phi$	trigonometric function	J	6
f	rotation term	J	6
g	geopotential	J	6
$P_n^m(\phi)$	associated Legendre polynomial	PJ	6
$w(\phi)$	Gaussian weight	J	11
$P_n^m(\phi)W(\phi)$	quadrature function	PJ	11
$R(\phi)$	combination of the above	PJ	13
$\frac{\partial u}{\partial \lambda}$	partial derivative	IJ	6
$\frac{\partial u}{\partial \phi}$	partial derivative	IJ	6
$\frac{\partial v}{\partial \lambda}$	partial derivative	IJ	6
$\frac{\partial v}{\partial \phi}$	partial derivative	IJ	6
$\frac{\partial v}{\partial \lambda}$	partial derivative	IJ	6
$\frac{\partial h}{\partial \phi}$	partial derivative	IJ	6
$C_m^u(\phi)$	intermediate spectral coefficient	MJ	10
$C_m^v(\phi)$	intermediate spectral coefficient	MJ	10
$C_m^h(\phi)$	intermediate spectral coefficient	MJ	10

Dimensions (Continued)

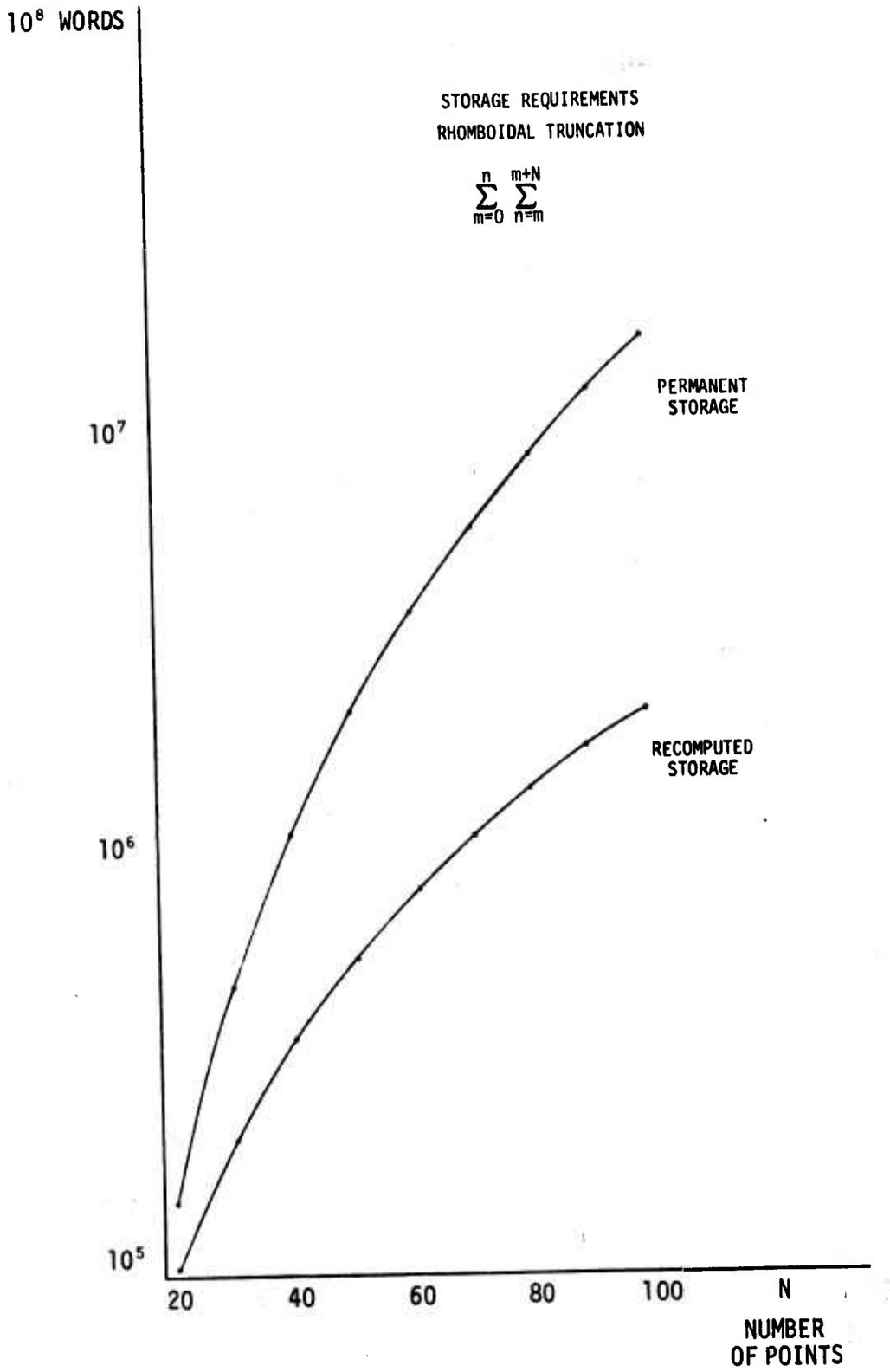
Item	Name	Dimension	Definition Page
$C_m^{\partial u/\partial\lambda}(\phi)$	intermediate spectral coefficient	MJ	15
$C_m^{\partial u/\partial\phi}(\phi)$	intermediate spectral coefficient	MJ	15
$C_m^{\partial v/\partial\lambda}(\phi)$	intermediate spectral coefficient	MJ	15
$C_m^{\partial v/\partial\phi}(\phi)$	intermediate spectral coefficient	MJ	15
$C_m^{\partial h/\partial\lambda}(\phi)$	intermediate spectral coefficient	MJ	15
$C_m^{\partial h/\partial\phi}(\phi)$	intermediate spectral coefficient	MJ	15
a_n^m	spectral coefficient	P	6
b_n^m	spectral coefficient	P	6
c_n^m	spectral coefficient	P	6
d_n^m	spectral coefficient	P	6
e_n^m	spectral coefficient	P	6
f_n^m	spectral coefficient	P	6
$Q_n^m(a)$	spectral coefficient	P	6
$Q_n^m(b)$	spectral coefficient	P	6
$Q_n^m(c)$	spectral coefficient	P	6
$Q_n^m(d)$	spectral coefficient	P	6
$Q_n^m(e)$	spectral coefficient	P	6
$u_m(\phi)$	intermediate spectral coefficient	MJ	14
$v_m(\phi)$	intermediate spectral coefficient	MJ	14
$h_m(\phi)$	intermediate spectral coefficient	MJ	14

Summary of Storage Requirements

Permanent Constants: J(5+3P)

Recalculated Functions: 12(IJ+MJ+P)

These totals are presented as a function of N(=M) in the following figure for RT.


10^8 WORDS
STORAGE REQUIREMENTS
RHOMBOIDAL TRUNCATION
$\sum_{m=0}^{n} \sum_{n=m}^{m+N}$
PERMANENT STORAGE
RECOMPUTED STORAGE
10^7
10^6
10^5
20
40
60
80
100
N
NUMBER OF POINTS

BIBLIOGRAPHY

1. Brigham, E. L., The Fast Fourier Transform, Prentice-Hall, 1974.

2. Chapman, S., Bartel, J., Geomagnetism, Clarendon Press, 1940.

3. Flattery, T. [private communication]

4. Haltiner, G. J., Numerical Weather Prediction, Wiley, N. Y., 1971.

5. Machenauer, B., and Rasmussen, E., On the Integration of the Spectral Hydrodynamical Equations by a Transform Method; Institut for Theoretisk Meteorologi, Kobenhauns Universitet, Report No. 3, 1972.

6. Orszag, S. A., Transform Method for the Calculation of Vector-Coupled Sums: Application to the Spectral Form of the Vorticity Equation, JAS, Vol. 27, No. 6, 1970.

7. Singleton, R. C., The Fast Fourier Transform, Stanford Research Institute, 1970.

APPENDIX

Fourier Transforms and FFT (See Brigham)

The Fourier transform of a function f(x), periodic such that $f(x) = f(x \pm 2\pi)$, is given by

$$F(k) = \frac{1}{2} \int_{-\pi}^{\pi} f(x) \exp(-ikx)dx.$$

The inverse transform is given by

$$f(x) = \sum_{k=-\infty}^{+\infty} F(k) \exp(ikx).$$

When we want to calculate the approximations to F(k) for a truncated transform, and N values of f(x) are known at equally spaced points, we get the "discrete" Fourier transform and its inverse.

$$F(k) = \frac{1}{M} \sum_{j=0}^{N-1} f(x_j) \exp(-2\pi ijk/N),$$

$k = 0, \cdots, M-1$, and

$$\tilde{f}(x) = \sum_{k=0}^{M-1} F(k) \exp(ikx)$$

If $N \geq M$ and f(x) is originally a Fourier series of degree $\leq M-1$, we have

$$f(x) \equiv \tilde{f}(x). \quad \text{(Brigham)}$$

For the case of interest here, we have generally

$$N = 2M.$$

Computationally, a straightforward solution to the system of equations above requires calculations that increase as N^2. However, a technique has been developed over the past 10 years which, by use of the symmetry properties of Fourier transforms, enables a reduction from N^2 to approximately $N\log_2 N$. For large N, this is an essential reduction. Reference to Brigham is the best way for the interested reader to follow the techniques required. At this time it is possible to purchase sophisticated hardwired FFT units that guarantee a speed for a given size of FFT. Since it is possible to solve for both the transform and inverse transform of a discrete set via this tool, these calculations in both blocks d and f refer to FFTs.

The speed and number of calculations for an FFT are proportional to each other and to $N\log_2 N$. Notationally, let us refer to the number of calculations for an FFT of N point values as

$$\text{FFT}(N).$$

We also refer to the time for one FFT(N) as $T_F(N)$.

For a provided FFT with guaranteed time T_0 for 1024 points (the standard), we then have

$$T_F(N) = \frac{(N\log_2 N)T_0}{1024\ \log_2(1024)} \cong \frac{(N\log_2 N)T_0}{10^4}.$$